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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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Forthcoming Events.

OCTOBER 20.
Wales and Monmouth Branch:—Lecture by Wesley Lambert on "Non-ferrous Metals" at Weston-super-Mare.

OCTOBER 26.
Manchester Association of Engineers:—Ordinary meeting at Manchester. Discussion on "The Microscope as Applied to Engineering," opened by J. S. G. Primrose.

OCTOBER 31.
Cast Iron Research Association:—Annual general meeting at Hotel Cecil, London.

Institute of British Foundrymen.

OCTOBER 27.
Lancashire Branch (Junior Section):—Opening meeting of the session at Manchester. Presidential address by T. Makemson, "The Prospects and Opportunities of Young Foundrymen."

NOVEMBER 3.
Lancashire Branch:—Ordinary meeting at Manchester. Lecture on "Facing Sands," by C. Presswood, B.A.

Craftsmanship and Science.

Many people who are familiar with the name of Sir William Bragg, the new President of the British Association, will know him in one or two capacities.

Primarily he is a brilliant physicist in the field of crystal structure. He is also a very charming lecturer at the Royal Institution on the occasion of their famous Christmas lectures to children. Two volumes of these have been published, and those who know one of these will recall the statement that "The production of cast iron was a tremendous step forward, one of those changes in a craft which not only make it a new thing, but even alter notably the history of the world." A statement of that kind coming from such an authority would give any founder new pride in his craft, and no one would be surprised to find his Presidential Address to the British Association dealing with Craftsmanship and Science.

Sir William spoke of the way in which science has promoted craftsmanship. The full appreciation of the use the craftsman makes of science is only appreciated when you consider a modern product of craftsmanship, such, for example, as a ship, and see how much of its construction is not merely dependent on science, but impossible without it. The screw or thrust block, the wireless outfit or the sounding apparatus, the refrigerator or the engine are essentially products of science. Craftsmanship has called upon science not in vain, and science has benefited by the craftsman's experience and knowledge.

There was an echo of the familiar in the claim that the most active modern industries are even founded on recent scientific research, such as electrical engineering, especially radio engineering and illumination, the motor industry, the rubber industry, the flying-machine industry, and that range of chemical industries that deals with dyes, explosives, fertilisers, artificial textiles, etc.

Sir William then seemed to distinguish between those industries which are in an early stage of development, in which design is changing rapidly and consequently in which mass production has not yet begun to take place, and those industries which have been so completely worked out that mass production has resulted. He appears to argue that new applications of scientific knowledge, new ideas, new processes, new machines, always result in progress, and that mass production represents, so to speak, a static fixed period which is a lull in the process of development.

We cannot help but think that this point of view is unfortunate because it tends to perpetuate the false idea that mass production, or as we should prefer to call it for English purposes, continuous production, and craftsmanship are opposed. We believe that nothing is further from the truth. It is true to a certain extent that a modern luxury motor-car may involve craftsmanship of an order which transcends that put into a medium- or low-priced car, but it is at least arguable that craftsmanship expended in producing a luxury car might have been deflected to some other purpose, since a medium- or low-priced car meets all ordinary requirements. It may also be true that the mere aggregation of productive machinery at one point, whether it be for the production of soap, matches, or oxygen gas, may involve a large number of workers who are not required, in any sense of the term, to be craftsmen, but even here the qualities of the craftsman, *i.e.*, intelligence, integrity and skill, are required, even if not in the same way. So far as the engineering industry is concerned we feel convinced that mass production requires not only a high degree of industrial organisation, but a high degree of individual skill, just because there is no time or opportunity for little adjustments which are the hall-mark of the products entirely made by hand.

We do not regard mass production as a lull in progress, but rather as a period of minor change instead of major change. The mass production of motor cars does not prevent changes going on in car design and production; they are the features of every annual show. On the other hand, a major change like the introduction of an automatic gear-box or a successful steam car might make such a revolution that mass production would not become possible for some years. Mass production industries require and, indeed, actually use science, just as much as newly-born industries.

Silicosis—A Foundry Rara Avis.

We have received from a number of prominent foundry-owners their considered opinion on the prevalence of this disease, and not one possesses any direct evidence of its presence. A statement from a foundry manager of unquestionable integrity and vast experience is typical of the general position in the industry. He says:—"Generally speaking, the sand in foundries is all used damp and there is very little dry dust, but it cannot be denied that in dressing dried cores and rubbing down loam moulds, especially in large work, a great amount of dry dust is made. A similar state of affairs occurs when loam moulds, brickwork, etc., are knocked to pieces. In spite of this I have never heard of the disease, but I know that foundry workers who are under suspicion of being tubercular are always advised to get out of the business as quickly as possible by their doctors on account of the dust."

Another writes:—"From our own experience, and after consulting a number of experienced foundrymen, we are of the opinion that the extent to which this disease prevails amongst foundry workers is very small indeed."

Now, the important point arising out of this proposed order is that, so far as can be ascertained, *at least some insurance companies will not demand any extra premium.* This is probably the best and most reliable evidence available as to the scarcity of the disease. A side-light on the subject of Home Office regulations is afforded by a comment in one letter that we have received, which insists that their imposition affects the larger firms more acutely than the smaller ones, some of which latter almost entirely escape; that the application of these Regulations varies in different districts—all affording added evidence as to the urgent necessity of an industrial organisation vested with power to speak for all and every section of the industry.

XUM

Foundry and Engineering Training on the Continent.*

By Vincent Delport, Ing.E.C.P.

A number of years ago, it was stated by British members of the engineering profession on more than one occasion that there were no finer engineering schools existing than the French schools for teaching theory; but, they added, the engineer trained at those schools was of no practical use until he had passed two or three years in the works, and been confronted with the actual problems that arise in practice.

Recalling personal experience of twenty years ago, the author can state that this appreciation was correct at the time. Since then, however, considerable progress has been made in France in the direction of practical training, although much still has to be done. In the larger schools, general engineering theory still holds a preponderant place in the curriculum, with the result that the poor fellows, who were already worked pretty hard in past years, now have to exert themselves to a still greater extent.

One of the best examples of the really practical school in France is the Ecole Supérieure de Fonderie, or Foundry High School, created for the purpose of training foundry engineers. The object of this talk is to explain in some detail the organisation and the working of that school, and also to give some idea of the methods that obtain in Belgium. It is hoped to place the Ecole Supérieure de Fonderie in the general scheme of technical education existing in France at the present time.

What is an Engineer?

First of all it is necessary that everybody should agree on the meaning of the word "engineer." It is understood that in England the engineer is the expert who drives the engine on the non-stop journey from London to Glasgow, also the good friend who drives the engine on the speed track from Catford to Charing Cross. On the Continent, the engineer is the man who has gone through a course of training and obtained a diploma, or degree, at one of the engineering schools. In France, our friend the engine driver is called a "mechanician," and his mate, the stoker, is the "chauffeur." As a matter of fact, anybody in France who has acquired some knowledge of mechanics and who operates a shop can call himself an engineer. Attempts have been made to legislate on the matter and reserve the title of engineer for the benefit of those who have obtained a diploma in one of the recognised schools. It will readily be understood, however, that such legislation would be very difficult to apply; so in order to differentiate one generally adds certain letters, or the name of their training school, after the word "engineer." It is in the latter sense that the author will use the word in the course of this lecture.

The Creation of the Paris High School.

The first idea of a special school for the purpose of training foundry engineers was expounded by M. Ronceray, chairman of the committee of the Association Technique de Fonderie, for training and apprenticeship, in a Paper which he contributed to the Liège Foundry Congress in September, 1921. Following up this idea, M. Ronceray obtained the active support of the Syndicat Général des Fondeurs de France, the French employers' federation, and the scheme gradually materialised.

The Government gave its support to the scheme through the channel of the department of education, and the director of technical education was delegated to keep in touch with the Syndicat des Fondeurs. It was agreed that if the programme of the Syndicat were accepted, the ministry would share in the financing of the enterprise to the extent of one-half the cost, the other half of the funds being furnished by the foundry-owners' federation; furthermore, the necessary lecture rooms, the foundry, and the pattern shop of the Ecole Nationale des Arts et Metiers, of Paris, were to be put at the disposal of the new institution. Since last year, with the exception of the foundry, the school has its own rooms and laboratories in the building of the Ecole des Arts et Metiers. On July 30, 1923, the scheme was definitely laid out by the Syndicat Général des Fondeurs and communicated to the representative of the Government. At the beginning of October, the names of the proposed directors of the future school were drawn up for approval, seven members of the board being designated by the Syndicat des Fondeurs and six by the Ministère de l'Instruction Publique, and on October 23 the decree was signed authorising the opening of the school with the President of the Syndicat Général des Fondeurs as chairman of the board *ex-officio*. The school was opened on January 7, 1924.

Candidates to the school are admitted after a competitive examination, which they must pass satisfactorily. Foreigners and non-diploma students can be admitted providing they do not exceed a certain proportion in numbers. At the opening of the school there were eighteen students, including one foreigner and one non-diploma student. Regular students pay a fee of 1,500 francs (£12) for their year's studies; foreign students and special students pay 2,500 francs (£20). The course of study is comprehensive and, in fact, represents the last stage in the training of the foundry "engineer" or manager following his apprenticeship.

Recruiting Grounds.

Candidates for the Ecole Supérieure de Fonderie come from two sources: the foundries themselves, and the leading engineering schools. The general method which is followed for the foundry candidates can be summarised as follows:—

First of all the candidates must have spent at least one year's actual practice in a foundry. Dating from next year, this stage will be raised to eighteen months, and eventually to two years, because experience has shown that those who had had the most practice beforehand derived the greater benefits from the school studies.

Apprentices are taken in certain foundries, usually between the ages of 13 and 16; during the first year they are given elementary notions on general subjects during one or two evenings a week; this constitutes the general preparatory course. During the next two years, the apprentices and also grown-up workmen who are willing to do so, follow a course of professional training. This course, which constitutes the first stage, is given in the various districts of the country wherever a number of foundries are grouped together. This preliminary course consists of lectures delivered in the evenings according to a programme laid down by the Syndicat Général des Fondeurs. At the end of this period, the apprentice who has at the same time been trained practically in the foundry, has become a qualified workman. If he wishes to improve himself, he then follows for one year a higher course which constitutes the second stage in his training as a specialist. This higher course is also given in each separate district, and generally takes the form of Sunday lectures and exercises. Thus the student becomes familiar with the elements of mathematics, physics, chemistry, drawing, etc. This complete system of instruction is developing according to a scheduled programme.

The workman now having been trained for three or four years, he may be employed in one plant or another. In fact, at any time he may choose not to pursue his studies and to remain in the ranks. But should he decide to reach the last stage and apply for admission to the Ecole Supérieure de Fonderie, he will have to follow a final preparatory course for one more year. This course is given at the various local trade schools, twice a week in the evenings and prepares the student for the examination which he will have to pass in order to be admitted to the foundry school. This examination consists of both theoretical and practical tests.

The College-Trained Student.

The second class of candidates are those coming from recognised engineering schools. They must have had six months' actual practice in a foundry. These candidates submit to the practical examination and are exempted from the theoretical part. The other candidates, who have worked up from the shop, only submit to the theoretical tests. The object of the examination is not only to eliminate candidates in excess of the fixed number, but also to be sure they have sufficient knowledge of mathematics, physics, chemistry, drawing, etc., on the one hand, and of foundry practice on the other to enable them to follow the course with profit. Non-diploma students who wish only to follow the course on certain specialties are accepted. The course lasts seven months from January 1 to July 31, the day's work lasting from 8.30 a.m. to 6 p.m.

The course consists of about 160 lectures on a variety of subjects, practical and theoretical, pertaining to foundry practice, and 70 practical exercises comprising laboratory work in the school's laboratories and actual practice in the foundry and pattern-shop, which are lent for that purpose by the Ecole d'A. et M. During each lecture a certain amount of time is devoted to discussion, during which the students can obtain explanations on points which have not been well understood. They are also interrogated by the professors on the subject of the lesson. Each week the students visit a foundry plant, and once a month they report on these visits.

Examinations are Practical in Character.

At the end of the year's work in July a final test has to be passed by the students; this consists of the complete study of a moulding proposition. In 1927 the subject was: "The Moulding of a Tandem Cylinder for Steam Engine," and at the examination for July this year the subject was: "A Locomotive Superheater." The students must submit a complete study of the moulding and discuss it before the board of examiners. They are also questioned on any of the subjects that have made up the whole year's course. In the moulding proposition which the students had to study this year they had to calculate the approximate weight of the finished casting, the weight of metal necessary to make the casting, the thicknesses of metal that would have to be machined, the contractions in various directions. They had to choose the manner in which they would prepare the mould, and give their reasons for their choice. They had to study the making of the pattern and of the cores, state the quality of sand that they would use both for the moulding and for the cores, describe the methods they advocated for filling the mould, and state their reasons, describe the heat-treatment, if any, and calculate the time necessary to make the pattern, the cores—briefly, the whole casting. A particularly difficult question was to calculate the reactions on the cores and on the various parts of the mould. The casting that they had to study was supposed to be capable of resisting a temperature of 450 deg. C. This final test serves to classify the students as they come out of the school, but account is also taken of the average marks they have obtained during the year for their various studies, reports, etc. Even if they have satisfactorily fulfilled all these conditions, they are not granted the diploma of foundry engineer until six months after they have occupied a post in a foundry shop. At that time they have to submit a thesis on a subject of their own choice and which relates to their actual experience in the foundry. It is only if this thesis is considered satisfactory that the diploma is finally granted to the student. Last year, 18 students obtained the diploma of Engineer E. S. F., and for the year 1927-28, 15 candidates successfully passed the examination entitling them to follow

* A Paper read last Thursday before the London Section of the Institute of British Foundrymen, Mr. W. B. Lake, presiding. The author is European Manager of the Penton Publishing Company.

the course. In addition to these 15 candidates were eight non-diploma students, including one mining engineer, the son of a Paris foundryman, one Japanese professor, one foundry manager of a large Czecho-Slovak works, one Spanish and one Italian student, one Brazilian officer, one Belgian steelmaker, and, a point of particular interest, one foundryman whose intention it was to follow only certain courses relating to his own specialty.

The Ordinary Apprentice.

It has been demonstrated how the foundry workman is trained from the time he is an apprentice to follow the course at the foundry school, and it may be interesting to learn a few details concerning the actual organisation for apprenticeship in the French foundry industry. Apprenticeship is not compulsory, but the Syndicat des Fondeurs, or employers' organisation, is using its influence in order that it should become compulsory in foundries of a certain importance. The employers' federation has prepared a complete programme which embodies their ideas on the training of apprentices. Their principal recommendations are:—Each foundry should take each year from five to seven apprentices for every 100 workers. Apprentices should be paid, and their wage should be fixed at about the same level as that of unskilled workers of the same age. In certain foundries the apprentices, at the end of their period of training, earn from two to three francs an hour. They occasionally receive a bonus on production, and at the end of their training they are granted the sum of 1,000 francs (£8). There is a certain difficulty in recruiting apprentices, because in France, as in many other countries, the foundry profession is not attractive to everyone. In order to encourage boys to follow this profession, it is recommended that lectures should be given in schools, that visits should be organised to the foundries, and that teachers in the primary schools should be asked to point out the advantages of the profession to their pupils.

The majority of foundry owners in France who have taken up the question of apprenticeship are in favour of training in the shop. They consider that the atmosphere of the shop makes for better workmen than the atmosphere of the school. It is recommended that apprentices should be grouped together under the direction of a skilled moulder, and where that method has been employed, very satisfactory results have been obtained. The period of training is generally three years, and it is only during the third year that the apprentices mix with the other workmen and work under the same conditions. It is only in cases where it is impossible to organise sections of apprentices in the foundries that it is recommended to have them trained in local professional schools. It is recommended that, at the end of his period of training, the apprentice should be transferred to another foundry, but it is considered essential that the actual period of training should be effected in the one foundry. It is also strongly recommended that indentures should be entered into between the foundry where the apprentice will be trained and the apprentice's parents. This indenture guarantees the terms under which the training will be effected.

It is recommended that in each important foundry centre lectures should occasionally be given on various subjects pertaining to foundry practice. Each regional group of the Syndicat des Fondeurs is asked to organise the courses and evening lectures which the apprentices must follow. During the first year, the lectures cover the subjects of arithmetic, elementary geometry, drafting, etc., and a complete programme of studies for the second and third year has been drawn up by the Syndicat. It is those lectures and courses that were alluded to when detailing how the apprentices are prepared for the examination for entry into the high school of foundry. These recommendations of the Syndicat des Fondeurs are followed in certain districts, and in certain individual foundries.

Belgian Conditions.

In Belgium the foundry training is not developed to such an extent as it has been recently in France. There are about three or four schools in Belgium where foundry apprentices are trained. There are also a number of technical schools where foundry courses are delivered on Sundays, and which are organised specially for foundry apprentices and workmen. There is an Ecole d'Arts et Métiers, which trains engineers for the foundry industry and other branches, and there is also a foundry correspondence school, the courses of which are followed by those workmen, foremen, and engineers who wish to increase their knowledge and specialise in that direction. However, a foundry high school will shortly be organised at the Université du Travail of Charleroi.

It may seem strange in an industrial country like Belgium, where there are about 800 foundries —iron, malleable, steel and non-ferrous—that there is not as yet a specialised school for training foremen and "engineers." This is explained by the fact that the average Belgian workman has generally had the advantage of a pretty thorough primary education, and his intellectual level is really very high. Many of these workmen have a disposition to read a great deal and to assimilate knowledge, with the result that it has been found that apprentices learn their trade very quickly when in contact with experienced workers. There are also a number of important foundries in Belgium where a section is organised constituting a veritable foundry school under the supervision of an experienced moulder. In every industrial district of Belgium there are many opportunities for those young men who wish to take advantage of learning their trade. Many of the foundry foremen and foundry owners in Belgium have trained themselves, and have acquired the necessary knowledge in chemistry, metallurgy and electricity in the various professional schools that exist in the country. It is recognised, however, by the leading foundrymen of Belgium that it is necessary to co-ordinate efforts in order that a specialised course of training for foundry practice should be organised, and the foundation of a foundry high school at the University of Charleroi will probably be the result of these efforts.

Place of Foundry School in the General Educational Scheme.

Reverting to conditions in France, it is now proposed to show how the Ecole Supérieure de Fonderie fits itself into the general scheme of technical and engineering training. Starting from the higher schools, there are in France four schools giving a course of general engineering and specialising on certain subjects at the end of the course; these are: the Ecole Polytechnique, the Ecole Centrale des Arts et Manufactures, the Ecole des Mines, and the Ecole des Ponts et Chaussées, all situated in Paris. The Ecole Polytechnique was founded in 1794 by Napoleon Bonaparte; it is a government school and prepares, principally, artillery officers. However, the men who at the end of their training graduate in the first ranks obtain government posts as naval architects or in the Department of Mines or Public Works, or in the tobacco, or powder and munition factories. Each year about 40 of these engineers are chosen in these various departments, but they first have to follow a course of training, which lasts one or two years, in special schools. The other engineers of the Ecole Polytechnique form the nucleus of the artillery officers' corps; but when they have completed their period of compulsory service they can resign their commission and seek employment as engineers in a private capacity, a step which a large number of them choose to take. Many engineers of the Ecole Polytechnique are to be found in the French railway administration. The Ecole des Mines trains especially mining engineers, and the Ecole des Ponts et Chaussées, civil engineers. These schools recruit their students from the first ranks of the Ecole Polytechnique, and also from other candidates who have satisfactorily passed the examination for admission.

As to the Ecole Centrale des Arts et Manufactures, or, as it is generally named, more briefly, the Ecole Centrale, it is perhaps the school in which the most complete training of a general nature is given, but where specialisation is pushed to a lesser degree than in the other schools. As the author is particularly familiar with this school, he will very briefly outline the organisation and curriculum. The Ecole Centrale was founded 100 years ago by a group of physicists and chemists, of which one was J. B. Dumas. Candidates for this school, before entering, must pass an examination showing that they have a sufficient knowledge of mathematics, physics, chemistry, etc., to enable them to follow the course of studies. In France, at the end of a young man's studies, it is usual to pass an examination called the Baccalaureat; this is the last stage of secondary education and entitles the student who has successfully passed the examination to the title of Bachelor of Science or Bachelor of Arts. It should be pointed out, however, that the programme does not compare in strength with that which is necessary to acquire the degree of Bachelor in Great Britain. It would probably correspond to the Matriculation examination. A young man who has obtained his degree of Bachelor of Science in France requires, normally, two years, and possibly three years, before he can pass the examination to enter the Ecole Centrale. In the author's time, the examination for admission into the school was passed in one session, but now it is divided into two parts, which have to be passed at one year's interval. This procedure already obtained previously for the Ecole Polytechnique.

A course of studies at the Ecole Centrale lasts three years, from October until the end of June. The morning of each day is devoted to lectures, and the afternoons are given up to drafting and laboratory work. Twice a week an hour is devoted to military training. Before the war, the practical training at the Ecole Centrale was limited to one or two visits each year to industrial works and a couple of topographical exercises out-of-doors. During the holidays it was optional for the students to visit works, and facilities were afforded them for so doing. At that time the laboratories consisted of a laboratory for electrical measurement and another electrical laboratory for the study of dynamos and alternators. There was also a laboratory for testing materials. Naturally, chemistry occupied a considerable proportion of laboratory work. It will be seen by that that the practical training at that time was considerably limited, and if we take the subject of foundry, for instance, it was just a part of the course of technology where one was given descriptions of a mould and a cupola, how a mould was made, etc. In the past three years, however, considerable extensions of the laboratories have enabled the curriculum of the school to be really more practical. Owing to the activities of M. Guillet, who has been Director of the school for the past four or five years, and whose name is well known to all metallurgists, several million francs have been collected from the principal industrial works in France, and this money has been used to build complete shops in a separate building, where the workings of practically every type of machinery can be effectively studied. These new laboratories enable the students to operate these machines themselves, and they include moulding machines and many examples of foundry equipment. There is hardly any branch of engineering, the principles of which are not studied during the three years' course.

During the third year of the course, the students specialise in one of four branches: public works, metallurgy, mechanical engineering and chemistry. All these students, however, continue to follow the general curriculum, but there are a few extra lectures which each class of student follows and which more particularly cover the subject of the specialty that they have chosen. This specialisation, however, is more especially taken up in laboratory work and in the various practical exercises.

At the end of the last term the students have to submit a thesis on one of a number of subjects, from which they may choose. This thesis has for its subject the layout and organisation of a complete plant, and the subjects are chosen according to the specialities that the students have decided on. Candidates must present a Paper on their subject and a set of drawings illustrating the layout and various details of the works that they have to study. A certain number of marks are allotted to this thesis, and an average is worked out, taking into account the various partial examinations that have taken place during the three years. A general average is thus arrived at, and in order to obtain

the diploma of "Engineer E.C.P.," a minimum number of marks must be attained.

Specialised Schools.

Though this highly technical education is centralised in Paris, yet the candidates for these schools can prepare for the examination for admission to some of the "lycées" or high schools which exist in various towns of France, but they have to go up and spend three years in Paris to complete their studies in the engineering school. There are, however, a number of local engineering schools of high repute, such as the Institution Industriel du Nord, the Ecole des Mines de St. Etienne, and others. Then there are a number of highly specialised schools, such as the Ecole Supérieure d'Electricité in Paris, Institut Métallurgique et Minièr de Nancy, the Ecole des Travaux Publics, of Paris, agricultural schools, etc. An "engineer" who has come out of one of the four big schools can, if he likes, specialise at the Ecole d'Electricité, for instance, but this is rather unusual, and these specialised schools generally recruit their students directly from those who have completed their secondary education, and passed the required examinations for admission.

More Practical Schools.

In quite a different sphere are the Ecoles Nationale des Arts et Metiers. Here we enter into a more purely practical scheme. Two of these schools were founded by Bonaparte, one at Compiègne in 1802, and one at Angers in 1806.

Later, the Compiègne school was transferred to Chalons, where it still exists. In more recent years, two other schools were founded, one at Angers in 1843, and one in Paris. It is in the Paris Ecole Nationale d'Arts et Metiers that is situated the foundry school. The students who follow the courses of these schools do not necessarily have to have undergone a full secondary education. They are given a sound technical education comprising the necessary elements of higher mathematics, physics, chemistry, etc., but to each of these schools is attached a workshop, and part of the time spent at the school is devoted to practical work in the workshop. Like the four big schools, these Ecoles Nationale des Arts et Metiers are controlled by the State, and the students who have satisfactorily completed their studies are given the title of Ingénieurs des Arts et Metiers, or, more briefly, Ingénieurs A. et M. They have not had such a high technical training, as in the schools previously mentioned, but they have, undoubtedly, had much better practical training. Many of the engineers who have passed through the foundry school have been recruited from the Ecoles Nationale des Arts et Metiers. Some of them, when they have completed their studies, choose to continue, and follow the higher technical courses at the Ecole Centrale, or another similar school.

Finally, to receive a more complete idea of the general scheme of technical training in France, it should be realised that in various localities there are "professional" schools, which give young men a purely practical training, together with the necessary elements of mathematics and science, and where the workmen have to follow the course given in these professional schools if they have the ambition to reach the foundry high school.

As we have seen, the Ecole Supérieure de Fonderie is a link between the higher engineering schools and the actual foundry shops. It recruits candidates from both sources. It has this characteristic, that the already-trained, but more technical engineer, before entering the school, must spend a certain period in a foundry, while the foundryman must first acquire a minimum of technical knowledge; thus, both classes of students are prepared to follow the curriculum of the school without difficulty.

In conclusion, we all know that there are some foundrymen who have worked up from the shop and attained a high position in their industry, but at the expense of a considerable number of years' toil and undirected work. An organisation such as the foundry school enables the ambitious foundryman to reach such a position in a minimum of time and trouble. The apprentice who accepts to follow the scheme of education that is set out for him and who starts at, say, the age of 14, may attain a responsible post in a foundry at the age of 25, with a full complement of technical knowledge and several years' foundry practice. This example, set by the Paris High School of Foundry, will soon be followed in Belgium.

The author is indebted to M. Ronceray and to M. Lamoureux, who, on receipt of a telegram, sent him information which enabled him to bring his notes up to date.

Source of Non-Ferrous Metals.

At the opening meeting of the London Local Section of the Institute of Metals, held last Thursday, at the Rooms of the Society of Motor Manufacturers and Traders, Limited, Pall Mall, S.W.1, Mr. S. W. Smith, D.Sc., F.I.C., delivered his chairman's address, taking as his subject "The Sources from which the World derives its Various Non-Ferrous Metals."

Before opening on the above subject, Dr. Smith made complimentary remarks about the work of their past-chairman, Mr. A. H. Mundey, and said he thought that Mr. Mundey's two years of chairmanship had been extraordinarily successful ones, and he could only hope that his year of office would be as successful.

He would also like to say how indebted they were to the Society of Motor Manufacturers and Traders for allowing them the use of their admirable rooms for their meetings.

The new chairman then commenced his geographical survey of the sources of some of the non-ferrous metals, saying that when he had embarked on the task of his survey he had found that it was only possible to deal with a very few of the metals in the space of time available.

In view of the fact that they were told by the geologist that the total of the valuable and useful metals, excluding iron, magnesium and alumina, amounted to less than 2 per cent. of the earth's crust, it was obvious that only where those metals had been concentrated or segregated by some natural agencies could workable ore deposits be found.

He regretted that time did not permit his going into any of the natural processes of concentration which gave rise to any of these workable ore deposits, but there was vast literature on the subject.

The chairman then gave approximate figures illustrating the relative tonnages of the world's production for 1927 as follows:—

World's Production, 1927.	*Approximate Figures.*	
1. Lead	1,700,000 tons	(–)
2. Copper	1,500,000 ,,	(+)
3. Zinc	1,300,000 ,,	(+)
4. Aluminium	200,000 ,,	(+)
5. Tin	150,000 ,,	(+)
6. Nickel	40,000 ,,	(–)
7. Antimony	30,000 ,,	(+)
8. Silver	7,700 ,,	(+)
9. Mercury	5,000 ,,	(+)
10. Cadmium	700 ,,	(+)
11. Gold	600 ,,	(+)

Tabulations were given showing the sources of each of these ores, the lecturer tracing the various districts on a map.

With the aid of a report by one who had recently visited these districts, Dr. Smith was able to give an interesting description of the districts where the mines are situated, touching on the conditions of living, etc., and in this connection he showed many beautiful lantern slides.

The meeting closed with a hearty vote of thanks to Dr. Smith.

Speaking at the annual dinner of the Institute of Petroleum Technologists, Engineer Vice-Admiral R. W. Skelton, Engineer-in-Chief of the Fleet, said that the fuel of the Navy was now almost entirely petroleum. The claims of our national fuel had been put forward recently very strongly in a new form—that of pulverised coal. For many reasons pulverised coal was almost a practical impossibility so long as petroleum existed. That was not the case, however, in the mercantile marine, and it was to be hoped that it had a future there.

Random Shots.

My little story of a music hall sketch set me reflecting how difficult it is to develop any really new "business" for the music hall stage. Twenty years ago the music hall was the only entertainment available, and a good "turn" would last an entertainer quite a long time, especially if he interspersed London and the provinces with tours on the Continent and in the Dominions.

* * *

To-day we are much more sophisticated. Even if we have not seen a turn before we know whether it has, or has not, that indefinable air of novelty or topicality. We spend more on amusement and we go oftener. The cinema has been very helpful in depriving us of the will to amuse ourselves, especially since we can walk into the friendly darkness at any time. Broadcasting has familiarised thousands with turns that might have been entirely novel to them if seen first on the stage. Yet paradoxically enough it does not kill the market, except perhaps for mediocre stuff. The rewards of the successful, when augmented by gramophone royalties, must be colossal.

* * *

And the rewards tend increasingly to go to brains which can devise novelties, but keeping them up in the task. How thrilling it was when for the first time we saw Nervo and Knox, for instance. But a good idea to-day, so great is the demand and so short the supply, goes round the world again and again. I do not often frequent music halls, but since its original production in Paris during the war, I have seen quite a dozen times the apache episode of the man who kills his girl and then, under the eye of a passing policeman, dances with the corpse.

* * *

I forget whether it was C. B. Cochran or Albert de Courville—more probably it was Andre Charlot—but one of these three claims to have invented the famous music hall phrase, "It's women like you who make men like me like women like you." This has brought down the house since its first appearance, and it is still going round the world. Do you remember George Robey rolling it out in his most unctuous tones?

* * *

Robey himself has experienced something of the fickleness arising from this constant demand for change. A period of the West End (during that series of Hippodrome revues that contained the Bing Boys) was followed by a time in the provinces, succeeded recently by a first-class London "come back." And yet look at the years it took Gracie Fields to reach the West End! The variety world has been under the weather for some time, but the recent success of the Palladium change-over to variety suggests a real recrudescence of interest.

* * *

Most jokes about the Great Majority are after the style of the following: "Did you hear that Blank had joined the Great Majority?" "Good heavens, no!" "Yes, he got married last week." This one, however, is less familiar, to me at any rate: "Well, Mrs. Harris," said the vicar, "so your poor husband has joined the Great Majority?" "Oh, don't say that, sir—I'm sure he wasn't as bad as all that."

* * *

I thought the B.M.G. movement (for Brighter Masculine Garments) was about to have a distinct fillip when I read this in the evening paper, until I realised that I was inadvertently skimming the domestic page. "Evening bags are to be seen this season in all shapes and sizes, in all colours ranging from the most brilliant hues to the palest of pastel shades. Charming evening bags can be made at home quite cheaply. . . ."

* * *

I should have been forewarned, because the same page gave an article on "Beauty for the Busy," which could not by any stretch of imagination have been intended for those creations of Mr. Edgar Wallace, the "busies."

Marksman.

Oxygen and Metals.

SOME FEATURES IN THEIR RELATIONSHIP.

By F. Johnson, D.Sc.

Introduction.

To exist in chemical combination with oxygen as an oxide appears to be the natural tendency of most metals, and, having once won the metals from this state of idle neutrality and negative utility, the ingenuity of man is greatly taxed to prevent them slipping back thereto. It is characteristic of mankind to apply the term "noble" to those metals which call for no effort on his part to retain in his service, and the term "base" to those which endeavour to escape from servitude. Nature herself assists in this emancipation and dissipates the energy accompanying the change; energy for which man must supply the equivalent, if he desires to win back the metals to the elementary state. This energy is usually obtained by burning carbon at the expense of the oxygen in the metallic oxide. From that stage onwards the element oxygen is for ever in the picture, sometimes being pressed into service as a purifying agent, *e.g.*, in refining, but always carrying an a guerilla warfare and seizing every opportunity to drag back to idleness the metal which has been so laboriously won and purified for man's use. Every time the metal is exposed to the atmosphere there is an "affair of outposts"; every time its temperature is raised, the outer defences suffer serious losses; every time a new strategic position is taken up, as in making a casting, further losses are experienced and hostile agents in the form of oxide inclusions find their way into the heart of the citadel.

Corrosion.

Oxygen is necessary for the appreciable corrosion of common metals, whilst dissolved oxygen increases the *acid* corrosion of metals, although its effect is overshadowed in an oxidising acid by that of the acid itself.

Differential Aeration.

According to U. R. Evans, oxygen bubbled through the electrolyte containing one electrode of a cell, renders it cathodic, the other electrode in the same cell becoming anodic. This explains the anodic functioning of metal in a pit or cranny, where oxygen cannot obtain free access. Thus the parts least accessible to oxygen are the more readily attacked, these being the anodes or corroded poles, from which the current, created by variation in oxygen concentration passes to the cathodes or aerated poles.

Passivity.

Although oxygen in general, increases the acid corrosion of metals, certain oxidising conditions may induce passivity, *i.e.*, relative immunity from attack by reagents which ordinarily attack the metals readily. This passivity is held to be due to the formation of very thin, adherent films of oxide.

Protective Character of Oxide Films.

Oxide films on the surfaces of metals often have the effect of retarding or checking corrosion. In the eighth Report to the Corrosion Research Committee of the Institute of Metals, R. May shows that brass condenser tubes containing 2 per cent. aluminium form a natural protective film in moving sea-water more rapidly than ordinary 70-30 brass. When scratched with the point of a needle, the protection breaks down locally, the "film potential" falls, *i.e.*, the potential difference between the film-covered metal and the clean metal is diminished. Only when the bare place heals up with the formation of fresh film, does the "film potential" rise to its former value and the protective action of the film is restored. This healing process is much more rapid in the case of the aluminium brass than in that of ordinary 70-30 brass, and is probably attributable to the formation of a tough, microscopically-thin film, consisting mainly of alumina.

The protective action of a thin, continuous, impervious coating of magnetic oxide on iron and steel has long been known (it is often produced on iron castings by water vapour coming in contact with the hot metal). When once the continuity of the coating is destroyed, the oxide acts electro-negatively and corrosion of the exposed metal is stimulated. Dr. Vernon has recently shown that a simple heat-treatment of freshly-cleaned copper at 75 deg. C. confers a considerable degree of immunity from tarnishing on subsequent exposure to the atmosphere, whereas unheated specimens tarnished to a reddish purple.

The protective film in this case is probably cuprous oxide, thick enough to protect, but too thin to be visible. It probably has its beginning in the absorbed layer of air which clings to the surface of a metal. The clinging atoms of this absorbed layer proceed to form oxide by taking up electrons from the metal.

Temper Colours.

As the oxide layer thickens still further, it becomes visible, by virtue of its ability to diffract light. The component colours of white light are sorted out according to their wave-lengths, certain wave lengths being absorbed by a film of given thickness and others being reflected. Thus the colour reflected by a film depends on its thickness, and as the thickness increases with increase of temperature or time, so a certain colour will indicate approximately the temperature at which the film was formed or the length of time of the exposure in the case of the temperature remaining constant. These so-called "temper colours" can serve as a guide in tempering steel, or in eliminating internal stresses from cold-drawn metal, *e.g.*, brass tubes. Temper colours are more characteristic on a highly polished than on a matte surface, which diffuses the light.

THIS Paper was presented on October 4 to the opening meeting of the Lancashire Section of the Institute of British Foundrymen, Mr. E. Longden, presiding. The author, Dr. F. Johnson, is head of the Metallurgical Department of the Birmingham Central Technical College. He has on several previous occasions contributed to the proceedings of the Institute.

Surface Condition and Oxidation.

Highly-polished surfaces are more resistant to corrosion, tarnishing and season cracking. Highly-polished surfaces are necessary for heat-tinting in metallography. Surfaces freshly fractured, metal-sprayed or pickled are specially chemically active as regards atmospheric oxidation. Nevitt has pointed out how metal surfaces produced in different ways behave differently. A piece of 70-30 brass is pickled and one half of the surface polished, the whole piece being then heated to 600 deg. C. The polished half becomes coated with a semi-transparent film of zinc oxide, the pickled half being thickly coated with black scale. Repickling destroys the erstwhile immunity from scaling of the pickled half.

Oxidation at High Temperatures.

The importance of ascertaining the resistance of metals and alloys to oxidation when heated needs no emphasis. The search for materials which will show immunity from this form of deterioration is being prosecuted with greater vigour every day. Steam-turbine blades, electrical resistors, electrical contacts, firebars, furnace tools, etc., are required by the insistent claims of economy and efficiency to withstand the ravages of oxidation when heated.

The question of whether metals will or will not become oxidised at high temperatures depends upon the dissociation pressures of their oxides. Noble metals have oxides, whose dissociation pressures approximate to or exceed atmospheric pressure at temperatures below their melting points. Base metals are those whose oxides have low dissociation pressures. A metal, *e.g.*, molybdenum, may form an oxide which is volatile and evaporates as fast as it is formed. Oxides having a low vapour pressure, form solid envelopes which may be physically non-cohesive or physically cohesive. Pilling and Bedworth have shown that oxidation is in no way governed by the properties of the metal, but is determined in character and degree, solely by the physical properties of the oxide formed, viz:—(a) its dissociation pressure; (b) its saturation concentration of oxygen in solution; and (c) its specific diffusional resistivity to oxygen.

Copper, nickel, iron, zinc and lead oxidise according to a law of quadratic proportionality. That is, assuming the oxide sheaths which form, to be physically perfect, a parabolic curve is obtained in which the quantity of oxygen combining is proportional to the square root of the time of oxidation. This is more clearly expressed by stating that if the increase in weight squared be plotted against the time of oxidation, the points lie on a straight line.

Aluminium and cadmium exhibit a similar proportionality up to the formation of a thin layer of oxide, which, however, becomes impervious and brings oxidation to a halt.

Oxides as Physico-Chemical Phases.

In the case of copper, nickel, and possibly cobalt, the oxide forms a simple eutectiferous series with the metal. With copper, the copper-cuprous oxide eutectic has a freezing point of 1,063 deg. C., and a concentration of 0.395 per cent. oxygen. For the purpose of neutralising the injurious influence of impurities such as bismuth and lead, and for controlling the "set" of cast copper bars, cakes, etc., a little cuprous oxide in the form of intercrystalline eutectic must be accepted as an ally. It is essentially a defensive alliance, in which the numerical strength of the minor partner is small, but its power in promoting internal cohesion and homogeneity great. Beyond a certain critical proportion,* however, the undesirable qualities of the minor partner are revealed and its value as an ally diminishes. Segregation of the eutectic is possible, one manifestation of this being the formation by exudation of small oxide-rich excrescences on the sides of the ingots, etc. The author has found that exudations from solidifying nickel are also rich in nickel oxide. The freezing-point of the Ni-NiO eutectic is 1,438 deg. C., *i.e.*, 14 deg. below the freezing-point of pure nickel. The concentration of the eutectic is 0.24 per cent. oxygen (1.1 per cent. NiO).

Surface Streaks on Polished Sheet Copper.

Another very real trouble associated with "tough pitch" copper is the occurrence of surface streaks or dull markings on sheet metal rolled from "tough pitch" cake of electrolytic quality. When such sheet metal is spun, it behaves quite well, but when polished, reveals what the spinner calls "stains." These stains have sometimes a cloudy appearance, and sometimes occur in very regular, well-defined streaks of light and dark brown, which cannot be removed by continued polishing. They appear on one side of the sheet

* Hanson, Marryatt and Ford, in their paper on oxygen in copper, stated as one of the foremost conclusions that the mechanical properties are not much affected by small quantities of oxygen, and a metal containing as much as 0.1 per cent. differs very slightly from pure copper. To this statement, the late Sir Gerald Muntz and the author took exception, and pointed out how enormously important such a proportion of oxygen really is. It is clear from Dr. Rosenhain's paper, "Modern Metallurgy and Ancient Industries," that this point has been well made, for he there makes the following statement: "It has recently been shown that in copper, otherwise entirely free from impurities, the presence of any oxygen is undesirable.

only, and that side corresponds with the top surface of the cake.

Some time ago the author examined the microstructure of copper buttons which had been cast in hot clay moulds, the surfaces being exposed to the air during the comparatively long period of solidification. The metal was electrolytic copper containing about 0.05 per cent. of cuprous oxide, and the structure resembled that of "tough pitch" copper as cast. A transverse section of the button, however, showed that there was a thin cap or crust on the top surface, very rich in cuprous oxide. The writer accounted for this at the time as being the result of segregation, the long period of solidification having enabled most of the cuprous oxide to float up to the surface. The same surface enrichment occurred when the copper was originally of almost eutectic composition.

Oxide-Rich Surface on "Tough-Pitch" Copper.

If the section of a wire bar or cake of "tough pitch" copper be polished and examined under the microscope, it will be seen to have an oxide-rich cap about 1 or 2 mm. thick, and the formation of this cap is due to the long period of time during which the casting remains molten. It had seemed to the author that the enrichment, in the case of the experimental buttons, could not be due to absorption of oxygen from the atmosphere, as the buttons tended to form a solid top crust before solidification was complete, owing to the heat in the clay mould. In discussing this matter with Mr. F. W. Harris, M.Sc., an English metallurgist, now with the Baltimore Smelting and Refining Company, U.S.A., the latter was strongly of opinion that atmospheric oxidation was the sole cause of the enrichment. If not the sole cause, it may well be the chief cause, owing to the avidity with which the surface of molten copper absorbs oxygen from the air. It will be necessary to ascertain by research what part, if any, segregation plays in the phenomenon.

Cause of Surface Ripples.

The existence of this oxide-rich cap on the surface of cakes, ingots and wire bars appears to explain what has puzzled metallurgists for many years, viz., the surface ripples or wrinkles that characterise "tough pitch" copper. They are not found on the surface of deoxidised copper castings, nor on any other metal or alloy known to the writer, and may well be due to a difference in the coefficients of contraction of pure copper and the copper-cuprous oxide eutectic. Eutectics usually contract less than pure metals, and the wrinkled crust would thus be the result of the inability of the eutectic-rich layer to keep uniform pace with the shrinkage of the underlying metal.

Reverting to the question of surface streaks on polished sheet copper, it should be stated that if the top of a copper cake be planed before rolling, the resulting sheets are free from streaks, thus supporting the author's contention that they are due to oxide enrichment. Furthermore, if the streaks be examined under the microscope, it is seen that they are densely populated with numerous minute particles of oxide, uniformly spaced, like those of the eutectic.

How Oxide Particles Produce Brittleness in Cold-Worked Copper.

It is interesting to observe that the metallic mass of copper in which these particles of oxide are dispersed behaves similarly to oxide-free copper when worked and annealed. When hot-worked, the eutectic alloy crystals flow in the direction of working, as shown in the photomicrograph of an alloy of eutectic composition prepared in the author's laboratory by Mr. C. D. Barwell. When cold-worked and annealed, the structure resembles that of ordinary copper after similar treatment, but it is more difficult to reveal by etching, the dense grouping of the oxide particles tending to neutralise the crystal-grain contrast produced by the orientation. The displacement of metal along slip-planes takes place just the same as in pure copper crystals, but there is much slip interference by the particles of oxide which break up the continuity of the planes of slip and thus account for increased hardness and brittleness. When annealed, recrystallisation of the strained metal occurs, and grain growth takes place quite independently of the particles of oxide, which do not appear to disturb the regularity of the space lattice of the crystal in which they are embedded.

Oxidation in the Melting of Metals

A few brief remarks only are possible on this extremely important and ever-widening subject. Excluding the special case of cuprous oxide in copper, it is probably true that the influence of metallic oxides is largely inimical in character, lowering the working quality and vitiating the physical and chemical properties. Oxide of thorium in tungsten is an instance of the extraordinary influence of a non-metallic substance in controlling the grain size, and may be, the grain shape. Stannic oxide in bronze is an instance of an inclusion having a wholly detrimental effect, weakening the structure and appearing in the form of exceedingly hard particles, which, in bronze bearings, have a cutting-scouring action on steel shafts. Its presence in zinc bronzes shows that its reaction with zinc is not quantitative. Alumina in aluminium-bronze and in other alloys is often present as an entangled filmy scum, which is incapable of uniform dispersion, incapable of self-release, sluggish, intractable and almost ineradicable. Zinc oxide has never, to the author's knowledge, been known to exert a powerfully harmful effect or to present serious difficulties. Efficient stirring is sufficient to enable it to rise to the surface of molten alloys, whilst care in skimming and in pouring will effect its exclusion from the casting. These considerations apply to most forms of pulverulent oxide, dross and scoria caused by the combination of fluxes with metallic oxides.

Genders and Haughton have found that a small amount of zinc oxide tends to remain in the upper layers of cast brass as minute, irregular striæ, and occasionally as six-pointed stars, although, owing to its infusibility, zinc oxide could not attain crystalline form at the temperature of molten brass. All oxides, however, do not possess such a comparatively low specific gravity (5.78) as zinc oxide, and do not therefore lend themselves so readily to expulsion.

The specific gravity of alumina (3.7 to 3.9) is, indeed, greater than that of aluminium. Lead oxide (9.2 to 9.5) will be incapable of floating in molten bronze or in any copper-lead alloy with less than 26 per cent. of lead. Stannic oxide (6.6 to 6.9) will rise to the surface of molten bronze, but not so readily as zinc oxide. Every precaution should be taken to prevent its formation, by thorough deoxidation of the metal before adding tin.

Nickel and its alloys are prone to dissolve carbon and reducing gases. Harmful oxides are formed when melting in an oxidising atmosphere. F. C. Thomson draws attention to non-metallic inclusions in nickel-silver, which he believes to be zinc oxide, but which resemble copper and nickel oxides, and are more likely to be so. The *via-media* is to melt the metal under fluxes in an atmosphere which is oxidising.

In steel non-metallic inclusions are abundant, but most of these consist of slag and sulphides. The author has often observed clusters of minute dark particles in steel similar to those described by Law as oxide inclusions. Such steel has been defective for deep stamping work. The particles may be iron oxide, alumina, or even highly dispersed particles of slag. They are regarded by some as being responsible for the familiar ferrite banding in mild steels.

Deoxidation.

Certain substances, essentially metallic in constitution, are used for the purpose of improving the physical properties of alloys as well as casting quality. These are known as deoxidisers, but their function is not only to reduce metallic oxides in the molten metal, but also to govern the behaviour of dissolved gases. The viscosity of molten metal may be increased by the presence of oxides and dissolved gases and the metal not only runs sluggishly into the mould, but does not penetrate the finer interstices thereof. The addition of a deoxidiser in many cases makes the metal run more freely, give sharper impressions and sounder castings. Some deoxidising substances have high vapour pressures at the temperature of the molten metal to which they are added, and their vapours have a great affinity for oxygen, the oxides thus formed being either volatile or capable of forming fusible slags. Sometimes a state of ebullition of the molten metal appears to accompany the addition of such deoxidisers. This may be due to the substance itself attaining its boiling point where locally concentrated. In making brass this occurs when zinc is added to the molten copper, any cuprous oxide being reduced and zinc vapour given off, the latter being converted to flocculent zinc oxide when it reaches the air. Moreover, this outward passage of metallic vapour carries with it gases formerly held in supersaturated solution in the metal.

Alloys which solidify at temperatures at which one of their constituents exerts a considerable vapour tension are frequently prone to form internal cavities on solidification. These cavities are often spherical in shape, and, being lined with a film of the condensed metal vapour, are easily distinguished from cavities to which oxygen has had access. The film can be removed by annealing, and such cavities exist in an alloy containing 20 per cent. cadmium in copper, but with 3 per cent. cadmium no cavities exist, the tension of cadmium vapour being lower than in the former case.

As has been pointed out, deoxidisers are often added to reduce oxides in molten metals. Some of these substances will also eliminate dissolved gases, and ensure the production of sound castings. This is not always the case, however, and occluded reducing gases derived from the gaseous products of combustion of the furnace may be the cause of sponginess in the castings. In such cases, the addition of an oxidising material may be beneficial, *e.g.*, red lead added to a lead-bronze (Portevin). An oxidising agent, however, will inevitably form other gases, *e.g.*, CO_2 from CO and O, and H_2O from H_2 and O, and these gases may not always be eliminated. Oxidised metal often indicates its condition by internal discoloration (made visible by fracturing), but this indication is not always given.

On the other hand, cast metal often breaks with a discoloured fracture, which at first sight appears to be unquestionably an indication of oxidation during melting. But closer investigation shows that the discoloration has been caused by infiltration of air into a spongy region whilst the metal was still hot, the spongy region having been caused by liquation of tin-rich fusible portions from the interdentritic spaces. Air may even penetrate into cavities caused by gas, and thus mask their real origin. One of the most certain sources of oxide contamination in molten metal is the surface scale formed during heat prior to melting. This will be greater in quantity, the greater the ratio, $\frac{\text{surface}}{\text{volume}}$, and so, scrap, consisting of thin sheet or wire will be particularly troublesome in this respect. Rapidity of melting will minimise this oxide formation, but special precautions should be taken to eliminate oxides thus absorbed before pouring.

Oxides may often be found in excess in welded joints, and fluxes, "deoxidiser" feeding rods and reducing atmospheres are among the precautions adopted to mitigate this difficulty.

Blast-Furnace Explosions in Germany.—According to a communication by Dr. Alfons Wagner, of Völklingen, in a recent issue of "Stahl und Eisen," opinions agree that the blast-furnace accident at Völklingen a short time ago was due to an explosion of coal dust. The explosion was in all probability caused by an endothermic reaction produced by the meeting of carbon and iron oxides in consequence of the crumbling in of a highly-suspended scaffolding in the burden. The author discusses various ways and means and makes suggestions for preventing the formation of scaffolds and removing them when once formed in order to prevent damage to stacks by explosions. An explosion in the cold-blast pipe at Oberhausen may be ascribed according to him to some of the explosive gas mixture having found its way back when changing over the blast for the Cowper stoves. The author in this case also discusses various ways and means for the prevention of such accidents.

Evaluation of the Properties of C.I. from Formulæ.

The first meeting of the 1928-29 session of the London Branch of the Institute of British Foundrymen was held at the Engineers' Club, Coventry Street, Piccadilly, W.1, when Mr. J. E. Hurst, of Sheffield, delivered a lecture on "Grey Cast Iron." Mr. W. B. Lake, J.P. (Branch-President), was in the chair.

Mr. Hurst said that, though the title of the lecture was a very wide one, namely, "Grey Cast Iron," it was desirable to confine attention to a particular aspect of the subject, and the particular aspect he wished to deal with was one which interested all thinking foundrymen. He proposed to deal with the attempt which had been made from time to time to devise some formulæ which would express a relation between the composition and the properties which one might expect to get from cast iron. It was a remarkable thing, very remarkable in many ways, that most of these attempts had been made by German investigators, and whilst he was afraid a good many serious-thinking English metallurgists were rather inclined to regard these formulæ with a certain amount of diffidence, the fact that the names of the German investigators associated with the formulæ were names which were highly respected in metallurgical circles made the formulæ all the more deserving of our serious attention.

Of the very concise formulæ that had been devised from time to time, probably the earliest one, and one with which metallurgist were very familiar, took the form of what might be called an equation. The formula was as follows:—

$$Sc = \frac{C}{4.26 - \frac{Si}{3.6}}$$

This had received great attention in this country at the hands of that well-known investigator, Mr. Cook. In this formula the letter C represented the total carbon content, the Si represented the total silicon content, and the Sc was a "kind of co-efficient." It is difficult to trace the exact origin of this formula.

The earliest publication of it, of which he was aware, was in the first edition of that famous German handbook Hütte, and in the French edition of Hütte it was stated that C represented the percentage of total carbon, Si represented the percentage of silicon, and that the figure 4.26 corresponded to the amount of carbon in a cast iron free from silicon at the eutectic point. The figure of 3.6 in the formula was the percentage of silicon which diminished the saturation of the carbon down to 1.0 per cent. Presumably one must read into that statement that the 3.6 per cent. of silicon was the amount of silicon with which the eutectic point was moved to a point corresponding to 1 per cent. carbon. That was all the information given to us with regard to that formula, and it was very difficult to appreciate what is conveyed by the construction of the equation.

Key to Formula.

Indicating the manner in which the formula was used, Mr. Hurst said that a series of values were assigned to the co-efficient. Thus:—

For general castings, Sc=0.9 to 1 per cent.

For loco castings, Sc=0.8 to 0.9 per cent.

For internal-combustion cylinders, Sc=0.76 to 0.85 per cent.

For ingot moulds, Sc=0.9 to 1 per cent.

For rolls, Sc=0.71 to 0.83 per cent.

For hard cast iron, Sc=0.75 to 0.88 per cent.

He supposed that "hard cast iron" meant "chilled cast iron."

This was the complete list of these constants taken from Hütte, and he considered it advisable to give it because he believed that the list had not been commonly available up to the present. The value of the formula, or the inferential value of the formula, he indicated by applying it to the production of good satisfactory general castings, as an example. The percentage of total carbon was divided by 4.26 minus silicon content divided by 3.6, and that division gave a value of 0.9 to 1.0 per cent. The same remarks applied to locomotive castings, ingot moulds, internal-combustion engine cylinders, and to hard cast iron. He confessed his inability to explain the basis on which the formula was constructed, but the formula could be turned round into the following form:—

$$3.6\ C + (Si \times Sc) = 15.366 \times Sc.$$

When the formula was in that form one could see at once that it was equivalent to saying that the total carbon content plus the silicon content multiplied by a co-efficient was equal to a certain arbitrary co-efficient which varied according to the character of the material one was making. That was about as far as one could go. It was noticed, by turning the formula round, as he had done, that it involved the summation of the total carbon, plus silicon, which it was important to bear in mind. This formula, in common with all the rest, was open to the objection that it ignored the influence of manganese, sulphur, phosphorus, and thermal conditions (by which latter he meant the rate of cooling and the casting temperature). One might assume, however, that the range of variation in the co-efficient was sufficient to take care of any variations caused by the variation in other constituents not included in the formula, but he considered that was rather a bold assumption.

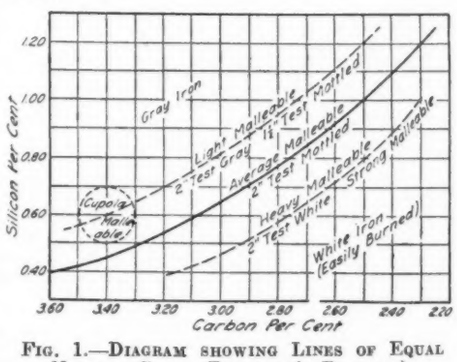


Fig. 1.—Diagram showing Lines of Equal Natural Chill (Thrasher's Diagram).

Without proceeding to consider the fallacy of the formula—and he considered that the word "fallacy" could fairly be used—it was necessary to point out that the practical value of a formula of that type was not very great. It seemed to him that it was equally as easy to remember a satisfactory composition or range of compositions for locomotive cylinders, rolls, or anything else as it was to remember the various co-efficients.

Another point with regard to this particular formula was that one could not help asking oneself the question, not knowing how the formula had been constructed, whether by any fortuitous combination of circumstances the formula was invariably correct and led invariably to satisfactory results. He believed all practical foundrymen would agree that if they used the formula they could not go far wrong. If, for example, one had a composition for general castings which, when the formula was applied, gave a co-efficient of 1.1 instead of 1—this difference was equivalent to the difference between the two limits—one would not expect to find that the general castings had very seriously deteriorated.

It appeared to be safe to say, therefore, that the results obtained by using the formula were not seriously wrong, but the point was whether the results obtained by the use of the formula were the very best that could be obtained in any particular case. Mr. Cook had given a good many examples from his extensive practical experience, and his experience had shown that this formula, so far as it had been applied had invariably given him satisfactory results. Also he had been able to show unsatisfactory results in particular cases which did not comply with the formula.

He (Mr. Hurst) did not think there would be the slightest difficulty in showing equally as many cases of castings the compositions of which did not comply with the formula, but which had still given satisfactory results in the particular type of work to which they were applied. As a matter of fact, in the case of centrifugally-cast piston rings, the actual composition which was specified did not comply with this formula, and it could not be denied that centrifugally-cast piston rings did generally give good results; indeed, it was generally admitted that they were the best. One might say that the objection was that they were cast centrifugally, but this discloses the fallacy of the formula, that it did not take into consideration the cooling conditions, and it was becoming more and more realised that the cooling conditions constituted one of the most important factors in the production of successful castings.

The Maurer Diagram.

Mr. Hurst then went on to deal with another concise expression of the relation between the composition and the character of the product, namely, the Maurer diagram, which was also of German origin. The diagram was not really new, but it was an application of an old method of representing the constitution of steels, which was dealt with ably by M. Guillet and M. Guillaume, and other investigators of about 25 years ago.

It was not very difficult, continued Mr. Hurst, to find among the mass of investigational work which had been done, numbers of cases which did not fit in with the diagrams. The diagrams did not take cognisance of manganese, sulphur and phosphorus, nor did they take into consideration the effect of differences in casting temperatures, and if one referred to some of the investigations of casting temperatures carried out by Hailstone or Hatfield one would find remarkable drops in the combined carbon content at certain casting temperature conditions without alteration in the total carbon and silicon content, and, therefore, without alteration of the position on the Maurer diagram, which latter depended on those two things. This showed that the diagram was likely to give false indications, because it left out of consideration the question of casting temperatures. It was generally realised that under perfectly stable conditions the whole of the structures of these cast irons would be the same, viz., ferrite and graphite, and it was largely due to the difference in rates of cooling that the structures which the diagrams attempted to represent existed at all.

Greiner and Klingenstein's Work.

Another diagram put forward by Greiner and Klingenstein, which was also German in origin, attempted to take the rate of cooling into consideration. The method adopted in this case bore a very close resemblance to another formula for cast iron, namely, the formula for the Perlit iron process. In the Greiner and Klingenstein diagram the thickness of the casting was indicated along the horizontal axis, and the sum of TC + Si on the vertical axis, as in the previous case.

Greiner and Klingenstein tell us that their diagram is applicable to cupola melted irons of not less than 2.8 per cent. of total carbon content (thus indicating a minimum), and operated at casting temperatures up to 1,450 deg. C. Presumably it was to be inferred from that statement that reasonable casting temperatures not exceeding 1,450 deg. C., made no really appreciable difference to the structural results obtained. The diagram was of similar type to that of the Maurer diagram, and followed upon the original method laid down by the alloy steel investigators, and it was open to the same objections.

The TC + Si Fallacy.

Dealing with the question of the sum of the total carbon plus silicon content, Mr. Hurst said that this was one of the points which was most open to criticism in connection with the various attempts at formulating a relation between the constitution of cast iron and its composition. We all knew that cast iron contained a large number of constituents, and any attempt to make a diagrammatic representation of the relation between the constitution and the variation of any one of that large number of constituents was a very difficult matter. In fact, it might be said that it was practically impossible to take cognisance of every constituent present in cast iron diagram-

matically, and it seemed to him that the idea of adding together the total carbon plus silicon content was purely a sort of trick though probably it was justified. It was advisable to attempt to ascertain whether there was any reason why the summation of the total carbon plus silicon content should be used in the diagrams, and so far as he could see there was no reason from first principles why it should give satisfactory results. The practice of adding the total carbon to the silicon content embodied the assumption that within the limits over which the total operated, a reduction in one of the constituents, coupled with a corresponding increase in the other, should be accompanied by identical results. If we considered the Greiner and Klingenstein diagram and applied to it a silicon plus total carbon content of 5 per cent., that total could be made up in a variety of ways, always bearing in mind the minimum of 2.8 per cent. total carbon specified by the authors. The sum of the total carbon plus silicon might be made up of total carbon 3 per cent., and silicon 2 per cent.; total carbon 3.25 and silicon 1.75; total carbon 3.5 and silicon 1.5; total carbon 4 and silicon 1; or it might be made up in any other way. All these compositions were presumed to give exactly identical structural results, all other things being equal. Was it reasonable to assume that all those different ways of making up the total would give the same results, and was it in accordance with practical experience? We should be inclined to say that it was not.

TC and Si Not Reciprocal.

This defect might also be regarded in another way, that the summation of the total carbon plus silicon content involved the assumption that the influence of silicon and total carbon on the structural constitution of cast iron were reciprocal, *i.e.*, that a reduction in the percentage of total carbon would have the same effect as would a similar reduction in silicon in changing the structure from grey to white, and, what was very important, that it did it in the same numerical value. Again, he did not think practical experience was in agreement with that. To put it in still another way, the variation in the amount of silicon produced an effect which could be balanced by the variation in the amount of total carbon quantitatively. There was no experimental evidence to support this; indeed, all the experimental evidence was to the contrary.

If the methods he had so far referred to of giving a concise interpretation of the relation between the structure and the chemical composition were examined along the lines he had indicated it would be appreciated that they did not take into consideration all the factors which we knew had an influence on the structure of the iron.

Thrasher's Diagram.

Another diagram, which from many points of view is the most satisfactory of the simple diagrams published, is that known as Thrasher's diagram. It was described originally in the American "Foundry" of December, 1915, and in view of its merit and its rationality it was worthy of more extended reference.

In this diagram (Fig. 1) the vertical axis indicated the silicon, and the horizontal axis indicated the total carbon.

The limit of total carbon content to which Thrasher's diagram applied was 2.4 per cent., and the limit of silicon was 1.2 per cent. Thrasher had, with remarkable intuition, indicated a line of further investigation by showing that with a 1½-in. diameter test bar this line became the mottled line. That was equivalent to saying that with a reduction in the section of the bar this average line was moved up into the position shown, so that it was safe to assume that as the bar was decreased in size from 1½ to 1 in., one could draw a series of curved lines along the diagram and each line represented the average mottled condition with each particular thickness of bar. In other words, Thrasher had disclosed the method of relating the total carbon content, the silicon content and the thickness of the bar in a perfectly scientific fashion.

A complete survey of the rate of cooling necessitated a series of these curves for each set of conditions, and the curves were to be transposed in the upward direction for quicker rates of cooling, and in the downward direction for slower rates. The extent of the transposition was not necessarily in strict linear relationship; *i.e.*, the extent of the transposition from a 2-in. to a 1½-in. bar curve was not necessarily the same as that from a 1½-in. to a 1-in. bar curve. As a matter of fact it could be confidently expected that the curves would gradually come closer, together. Within a very narrow range the effect of any variation and size could be detected by simple interpolation. He had constructed a diagram covering other sizes of bar from ½-in. to 3-in. in diameter, and he believed it would be of some value in determining the limits of total carbon and silicon content which would give the border line structures, which it would be agreed were those accompanied by the best results. As in all other diagrams, the influence of manganese, sulphur, phosphorus and casting temperature was neglected, and a multitude of similar diagrams would be needed to cover every possible condition.

He believed it would be found, if one examined diagrams drawn correctly to scale, that they gave results which were not very far from those obtained by practical observations. The diagram presented the relations in a more rational manner, and avoided the irrational summation of the total carbon and silicon contents. The personal experience of Mr. John Shaw, extending over many years, supported the statement that the figures given by the diagram are correct. For this and other reasons he considered that the diagram deserved extended examination.

Summarising the position, Mr. Hurst said it could safely be stated that whilst the German diagrams which had been put forward during the last few years might be expected to give truthful indications so far as they could be applied, *i.e.*, so far as we might assume the influence of casting temperature and the rest of the composition could be neglected, we in this country, and particularly iron-foundry metallurgists should take a very strong line against this attempt to build up concise formulæ based on the summation of total carbon and silicon contents. All the evidence seemed to point to the fact that it was nothing more or less than a trick to enable a diagram to be constructed, and the trick had absolutely no justification in practice. He felt that British cast-iron metallurgists were very likely to be misled by the extent of the German support which had been given to the diagrams he had referred to.

A New Foundry for Derby.

Qualcast Foundry Company, Limited, Capital.

The Qualcast Foundry Company, Limited, of Derby, has had a record year, and at the annual meeting of shareholders, held at the Midland Hotel in that town, on Tuesday, it was mentioned that extensive developments are to take place. Mr. J. E. V. Jobson presided over a good attendance.

Following the adoption of the financial statement, Mr. Jobson said that the capital of the company to-day was £125,000, all in ordinary shares of 5s. each, but, as that capital was not issued until July 2 last, it did not, of course, appear in the accounts and they had had no benefit from it during the past year. It was, however, the intention of the Company to utilise the new capital to enable them to remove their works from their present leasehold premises to a new freehold site of seven acres on the other side of Derby. "The plans for the new foundry, which is the first part we shall move," he said, "are now well in hand, and we anticipate being in production in our new foundry before we meet again." The new foundry was being laid out so as to give them an increased capacity of 50 per cent. on that side of their business. The new capital had, in the meantime, been invested, and they had £40,000 in War Loan, and £15,000 on deposit account.

So far as their trading profit on last year was concerned—£24,261 8s. 1d.—that, he said, was a record for the business, and he might say that each department had done better than ever before. Perhaps that was a suitable place to pause, in case there were any questions they might wish to ask regarding the accounts, but if there were no questions, he would pass on, for the benefit of the new shareholders, to a short review of the history of the Company, and then deal with the prospects of the future. The business, he said, as far as they could trace, originated about 1801 in Sheffield, where it was founded by his great-grandfather. It was originally a stove and grate factory. About 1849 it was removed to Derby by his grandfather, and they went to their present premises some short time later. During the whole period of its existence, although it had had its good and bad years, it had always met its liabilities in full, which was a record of which he felt very proud. The war period, of course, upset all business, and the Company was a controlled establishment on war work, and he thought they held the record for the country for output of their class from a foundry of their size. When peace came they developed the production of precision repetition iron castings, especially for the automobile, gramophone and kindred trades, adopting the trade mark "Qualcast," which was an abbreviation of the two words, "quality castings."

Proceeding, he said they set their minds on producing a product which would machine up rapidly and give the machinist a cheaper finished product. That they were successful was shown by their growth in turnover and profit, and to-day they could scarcely go a mile on the road without passing some "Qualcast" products. In order to fill up part of their works which had been used for stoves and grates before the war they had to find another completely manufactured line, so they took up lawn-mowers in 1922, using their old trade mark, and, at the present time, he could say with pride that there was not a country where their name was not known.

Future Prospects.

Speaking with regard to the prospects of the future, Mr. Jobson said he was in a position to state that although personally he was of the opinion that they had almost reached capacity on what they could turn out of their present foundry, yet the turnover in the department for the first ten weeks of this year showed an increase of 3.4 per cent. over the corresponding period last year, and their order book was even better filled than at this time a year ago. "In our lawn-mower department, where we are not so pressed for space, we are budgeting for a considerable increased output over last year," he said. Taking those facts into consideration they could, he thought, confidently look forward to at least as satisfactory a year as last. They could not, of course, get the benefit of their new capital to any extent, but even if they ignored any interest from their investments and history repeated itself, and their earnings were the same as last year, they would earn 19 per cent. on their issued capital if all went well.

During the past year they had had the pleasure of welcoming their sales manager, Mr. Richardson, on the Board, and, of course, his appointment would require confirming. As head of the firm I should like to put it on record how much I appreciate the loyal backing of every member of our staff and employees. We have made heavy calls on them at times, but they always respond with a will, and I am more than pleased to see so many of them amongst our list of shareholders, and present with us to-day.

Mr. Jobson then formally moved that the accounts as presented be passed, and Mr. J. A. Alton seconded, a unanimous vote following.

Mr. O. J. Jackson and Mr. F. S. Richardson (sales manager) were re-elected as members of the Board, and Messrs. R. J. Weston & Company, of Derby, were re-elected auditors.

The Motherwell Bridge & Engineering Company, Limited, have been successful in securing the contract from the Union Government of South Africa for steel bridges required by its Public Works Department for roads over the Vaal, Sand, Little Amanzimtoti, and Illovo Rivers. The order is for ten spans of 201 ft. each, one span of 160 ft., two spans of 140 ft. each, and one span of 100 ft. The weight of steel used will be about 750 tons. Following the placing of the contract a night shift has been started with a view to clearing off outstanding orders. This and other contracts on hand will keep the works fully employed for a considerable time.

Effect of Various Elements on Malleable Cast Iron.*

By L. E. Gilmore.

Foreword.

It has been well said that one cannot see the forest for the trees. It is stated this element hardens; that element softens; this one is deleterious, and another is beneficial. And so it goes. It is essential to study the effect of each element, all other variables being constant. When one reaches realities, however, what it is desired to know is the resultant effect of these various elements in their combinations and reactions with each other on the finished product. How can the founder use the effect of one to neutralise that of another or the combination of two or more for a desired result? So it is desirable periodically to assemble available information and obtain a general view of the more important effects of various constituents on malleable cast iron.

Essential Condition of Carbon.

In the production of good quality blackheart malleable one must cast the hard white iron with total carbon combined and then set free all this carbon by suitable heat treatment. Not only must the various elements be so combined and balanced that no free carbon is present in the white iron casting, but the relationship must also be such that the carbon can be freed readily during the anneal. In addition to such control the strength and ductility of the iron is also dependent on the total quantity of certain elements present, notably the carbon.

Effect of Phosphorus.

Phosphorus is usually between 0.10 and 0.20 per cent. and seldom exceeds 0.20 per cent. in commercial malleable. Phosphorus about 0.25 per cent. is no longer entirely soluble in the ferrite of the finished product.[1] Up to this amount there is no effect on graphitisation, but a direct effect on physical properties. Phosphorus up to about 0.20 to 0.25 per cent. strengthens the metal without decreasing its ductility.[2] As about 0.25 to 0.31 per cent. phosphorus, depending upon the amount of carbon present, produces free phosphide, the effect of higher phosphorus is to cause some brittleness and less strength.[3] Phosphorus in solution in iron is harmless. Free iron phosphide is dangerous.

Manganese-Sulphur Ratio.

The very important and chief function of manganese in malleable iron is to combine all the sulphur present in the form of manganese sulphide. Abnormally large amounts of sulphur are practically harmless if the manganese sulphur ratio is maintained.[4] Some slight excess of manganese is required. Manganese sulphide is neutral. Any excess sulphur present over manganese sulphide forms iron sulphide and retains about 0.80 per cent. carbon combined even after the most drastic anneal. A very large excess manganese of the order of 0.8 per cent. excess is required to produce this same effect on malleable.[5] The excess manganese forms double carbides with iron and carbon and will retain part of the carbon combined after anneal, when present in large amounts. When manganese and sulphur neutralise each other they practically have no effect on the physical properties of the finished iron.

Silicon-Carbon Balance.

With phosphorus, manganese and sulphur in normal proportions the silicon-carbon balance determines the physical properties of malleable. For the sake of simplicity the author assumes fixed conditions of casting temperature and of the variables that might affect the rate of cooling. In normal foundry practice these variables, which have very important effects on the condition of carbon in white iron, become standardised and may be regarded as constants for the purposes of this discussion.

Any primary graphite in the white iron casting greatly weakens the final product. To avoid this the higher the percentage of carbon the lower the silicon must be, or *vice versa*. Silicon is a well-known promoter of graphitisation, both in iron as cast or during anneal. Its ability as a "promoter" is dependent upon the relative proportion of carbon and silicon.

Combined carbon, except in minute amounts, in the finished annealed iron is undesirable, for although it may increase tensile strength it greatly reduces ductility.

Low Carbon with High Silicon Makes Strongest and Most Ductile Iron.

The lower the percentage of carbon the greater the strength and dutility. Carbon 1.7 per cent. is about the minimum which can be readily precipitated in commercial annealing, so it is well to aim for carbon well above this figure. Carbon 2.20 to 2.30 per cent. in a standard ⅝-in. dia. test bar will give 20 to 25 per cent. elongation in 2 in., with tensile strength from 24.1 to 25.4 tons per sq. in. Within a limit of silicon low enough to cause no precipitation of graphite in white iron, silicon has no effect on elongation. An increase of silicon from 0.70 to 0.90 per cent. with carbon constant about 2.25 per cent. will increase the tensile strength 0.9 to 1.3 tons per sq. in.

With increasing carbon, ductility becomes less and less with a corresponding loss in tensile strength. The combination of greatest strength and ductility is a low percentage of carbon with high silicon.

Probably every producer of malleable castings at one time or another has experimented with the addition of various elements to his iron in furnace or ladle. In general, it may be stated that if the usual elements found in malleable are properly balanced, then the addition of any quantity of other elements will upset the balance. The result of this unbalancing may become evident either by causing precipitation of graphite in the hard iron or by retarding or accelerating the precipitation of temper carbon during the anneal.

Those elements which with increase have the power progressively to throw out primary graphite have also the power to help release combined carbon during the anneal. On the other hand, those elements which tend to hold carbon combined in the white iron have similar effect in retarding the anneal.

Aids to Graphitisation.

If silicon is present just under that which would cause separation of primary graphite, the addition of any other "precipitator" element would be additive to the silicon and make the iron more or less grey. In general, these elements go into solid solution in iron thus leaving less iron to hold the carbon which then precipitates. Such elements can be used to replace the silicon in whole or in part, and when used in quantities, to maintain proper balance with the carbon, normal malleable iron may be produced. Apart from silicon, aluminium is the most commonly known precipitator of carbon. Titanium, nickel, uranium and zirconium act in a similar manner. In iron containing practically no silicon, 0.10 to 0.15 per cent. titanium or aluminium or 0.50 per cent. zirconium prove effective substitutes.[6] Calcium silicide is used to make a grey iron from white iron.[7]

Inhibitors of Graphitisation.

Inhibitors of annealing, which also tend to hold carbon combined in white iron, are in general elements which form carbides or double carbides when present with iron and carbon. Of course, the absence of silicon or like "precipitators" may inhibit graphitisation. Abnormal amounts of sulphur or manganese as already noted will act to the same effect. Other inhibitors are antimony, boron, cerium, chromium, molybdenum, selenium, tellurium and tin.[8] For instance, about 0.25 per cent. chromium added to normal malleable is effective in holding a pearlitic matrix (about 0.80 per cent. combined carbon), after anneal. Vanadium acts in a manner similar to chromium in assisting carbon to remain combined.[9]

In the final analysis, malleable iron should be thought of not so much as an alloy in which each element has a fixed and individual function but more as a mixture of compounds and interacting elements which, when properly balanced with each other, will produce the highest quality iron. It is the manner in which the elements unite in compounds and the relative proportions of certain elements as well as the total percentage of any one element that determines the degree of success in producing good malleable castings.

* A Paper read before the Philadelphia Meeting of the American Foundrymen's Association.

[1] H. A. Schwartz, "American Malleable Cast Iron," p. 59.
[2] H. A. Schwartz, "American Malleable Cast Iron," p. 292.
[3] W. H. Hatfield, "Cast Iron in the Light of Recent Research," p. 51.
[4] L. E. Gilmore, "Proper Sulphur Manganese Ratio Must be Maintained," Vol. 55, p. 734.
[5] Unpublished experiment by the Author.
[6] H. A. Schwartz, U.S. Patent 1,636,657, July 19, 1927, and U.S. Patent 1,640,674, August 30, 1927.
[7] Augustus F. Meehan, U.S. Patent 1,499,068, June 24, 1924.
[8] H. A. Schwartz and G. M. Guiler, "Chemical Elements Inhibiting Graphitisation," Vol. xxxii. p. 639, Trans. of the American Foundrymen's Association, 1925.
[9] W. H. Hatfield, "Cast Iron in the Light of Recent Research," p. 87. Charles Griffin & Co., Ltd., London, 1912.

Catalogue Received.

Belt Conveyors. We have received from Messrs. Ira Stevens, Limited, Ashton-under-Lyne, a publication entitled "The Conveyor Belt: Installations and Examples," to which is added a supplement on bucket elevators. This brochure is a border line publication, and we hesitated before finally deciding to deal with it under the caption "Catalogues Received." It is practically devoid of advertising matter, and actually constitutes a reliable textbook on the subject. Its 54 well-illustrated pages are divided into eight sections, which carry the subject from the basic principles of conveying to supervision. We were much interested in the figure printed on page 42, which, unfortunately is placed upside down, as it represents an apparatus of great potentiality in foundry practice, in cases where castings are stripped over gratings and the sand has to be carried up a height to be reconditioned and milled. No illustrations are given of foundry applications, but there are shown several allied duties. Founders are mistaken when they imagine that sand is the most difficult of all materials to convey, some cereals are equally troublesome. Messrs. Stevens have kindly intimated that they will send copies along to any of our readers who may be interested in the subject of conveying, and we strongly advise them to take advantage of the offer.

Book Review.

Workshop Practice. Edited by E. A. Atkins, M.I.Mech.E., and published in about 30 weekly parts at 1s. each by Sir Isaac Pitman & Sons, Limited, Parker Street, Kingsway, London, W.C.2.

Part I.—If we were to confine our attention to this particular section, we could only say that for apprentices to the pattern-making trade it is excellent, but for the moulder only of limited utility, but we are promised some 1,750 pages, and as sections are to be devoted to pattern-making, foundry work and casting, and the authors of these sections are to be Mr. Chas. A. Otto and Mr. J. McLachlan, one can be reasonably sure in advance that the foundry industry is to be well catered for. As the modern foundry manager has to cover so many fields of activity in the normal course of his duties, it appears to us that a subscription by the ambitious young foundryman will be well worth while.

Notes on the Routine Analysis of Cast Irons and Iron Foundry Raw Materials—No. 6.

By Arthur Smith, M.A.

(*Continued from page* 212.)

Process for Phosphorus Determination.

Weigh out 0.5 gm. of the sample of cast iron, transfer to a suitable beaker, and add 60 c.c.s. of dilute nitric acid (sp. gr. 1.2). Warm cautiously till solution is complete, and filter off the graphite, etc., washing thoroughly with dilute nitric acid wash. Heat the filtrate to boiling and add 10 c.c.s. of the permanganate solution. Boil until the pink colour disappears and a brown precipitate of MnO_2 has separated out and persists. Clear this precipitate by adding ferrous sulphate solution, drop by drop, with frequent stirring. To the warm solution (about 70 deg. C.) add 1 gm. solid ammonium nitrate, and when dissolved add 25 c.c.s. ammonium molybdate solution. Stir vigorously for one minute, allow to settle, filter through asbestos pad in a Gooch crucible or similar apparatus (a 9 cm. filter paper may be used if such filtering apparatus is not available). Wash the precipitate thoroughly with dilute HNO_3, wash, and finally wash free from acid with neutral ammonium nitrate wash. The precipitate is next removed to a small beaker or small flask, and 100 c.c.s. distilled water is added and standard NaOH solution run in until the yellow precipitate has dissolved. Two drops of phenolphthalein solution are next added, and the solution titrated with standard HNO_3 until one drop of acid renders the solution entirely colourless. The number of c.c.s. of NaOH used, less the equivalent number of c.c.s. of HNO_3 used, multiplied by the factorial value of the alkali, gives the amount of phosphorus present in the sample. If the above method is carried out with due attention to details the results will be sufficiently accurate for most foundry purposes.

To ensure success with this method, the conditions under which precipitation is made must be rigidly adhered to. The most important conditions are the following:—(1) All the phosphorus in the sample must be converted to orthophosphoric acid, hence the necessity for solution in moderately strong nitric acid; (2) the correct excess of free acid and no more should be present; (3) a considerable excess of ammonium nitrate must be present; (4) correct temperature and agitation greatly accelerates precipitation; (5) when this method is used in the presence of arsenic acid, the temperature of the precipitation should be kept below 35 deg. C., at which temperature most of the arsenic will remain in solution while the phosphoric acid will be completely precipitated, but, of course, precipitation may take several hours to reach completion at this low temperature; and (6) the contamination of the yellow precipitate by such substances as ferric molybdate, molybdenum trioxide MoO_3, ammonium "poly"molybdates, basic-iron salts and the like, must be carefully guarded against. Their precipitation along with the yellow precipitate of ammonium phosphomolybdate is often due to precipitation at too high a temperature as well as when the concentration and degree of acidity of the solution is incorrect, before the addition of the ammonium molybdate. Hence the remedy is to ensure that the solution is neither too strong nor too dilute, contains just the right amount of free acid, and that the temperature is not too high. Where such contamination is liable to occur in any particular sample of cast iron, slow precipitation at a temperature not exceeding 35 deg. C. may be tried with advantage.

As one alternative to the volumetric finish, the yellow precipitate may be dissolved in ammonia, and the phosphorus precipitated from that solution by magnesia mixture, with subsequent ignition and final weighing as magnesium pyrophosphate. Where a gravimetric finish is desired, this method is much superior to drying and directly weighing the yellow precipitate, as it eliminates errors arising from impurities in the original yellow precipitate.

Finishing Details.

The solutions required are (1) *Ammonium Hydrate Solution.*—Dilute 500 c.c.s. ammonium hydrate (0.88 sp. gr.) to 1,000 c.c.s., and (2) *Magnesia Mixture Solution.*—Dissolve 60 gms. of magnesium chloride together with 80 gms. of ammonium chloride in 600 c.c.s. of distilled water. When dissolved add 400 c.c.s. of ammonium hydrate (0.88 sp. gr.). Allow to stand for 24 hours and filter and use the clear filtrate as the reagent.

Dissolve the yellow precipitate through the Gooch crucible by adding just enough ammonium hydroxide to cause complete solution. Wash, first with dilute ammonia, and then with hot distilled water. Just neutralise the liquid with hydrochloric acid, then add 25 c.c.s. of magnesia mixture of 30 c.c.s. of 0.88 ammonium hydroxide. Stir well and allow to stand for two hours. Filter through an ashless filter paper. It is best to decant the clear portion through the filter paper and then filter the turbid residue. (Do not wash by decantation.) Wash the precipitate on the filter with dilute ammonium hydrate (one part of 0.88 ammonium hydrate to three parts of distilled water) till free from chlorides (test with $AgNO_3$ in HNO_3 solution). Dry the filter thoroughly, transfer dried precipitate to a crucible. Alundum crucibles are very useful for this type of work, especially where the stock of platinum is strictly limited. Ignite the filter paper separately and add the ash to the precipitate. Ignite slowly at a low heat, at first, and finally ignite strongly, till the residue is pure white and gives constant weight from successive weighings in the cold. The phosphorus is thus precipitated as crystalline magnesium ammonium phosphate $Mg.NH_4.PO_4.6H_2O$ and ignited and weighed as magnesium pyro phosphate, $Mg_2P_2O_7$, containing 27.93 per cent. phosphorus.

The combined filtrate and washings should be measured in order to make an allowance for the slight solubility of magnesium ammonium phosphate even in strongly ammoniacal solution. Careful experiment shows that it is advisable to allow one milligram of $Mg_2P_2O_7$ for every 55 c.c.s. of filtrate and washings. For check purposes, in the absence of more than negligible amounts of arsenic and titanium, the above method is extremely useful and accurate.

The amount of initial sample taken should vary with the amount of phosphorus expected in the grades of iron being dealt with.

Some chemists prefer to finish the quick wet oxidation method gravimetrically by converting the yellow phosphomolybdate into lead molybdate, and there is much to be said for this method where speed somewhat approaching that of the volumetric finish is aimed at. None of the gravimetric methods, however, comes up to the volumetric finish for speed coupled with reasonable accuracy. Cheap yet accurate estimations are always essential for general routine work in the average metallurgical laboratory controlling cast-iron products.

The Lead Molybdate Method.

In the lead molybdate method the yellow precipitate, after being carefully washed free from iron salts, is dissolved through the filter with the smallest amount of ammonium hydrate into a suitable beaker. About 10 to 15 c.c.s. of concentrated hydrochloric acid is added, the contents of the beaker warmed, and then 12 to 15 c.c.s. of 5 per cent. lead acetate solution is added. More of this solution may be required in the case of very high phosphorus irons. To this is added a boiling solution consisting of 50 c.c.s. of concentrated ammonium acetate together with 10 gms. of ammonium chloride dissolved in 50 c.c.s. of boiling distilled water. A white precipitate of lead molybdate which settles readily is thus obtained. The hotter the solution is kept, the more readily this white, rather flocculent precipitate settles. It is now filtered, washed with hot distilled water, and ignited to constant weight. Lead molybdate contains 0.7 per cent. phosphorus.

Arsenic and Titanium Demand Modification.

For this estimation in low-phosphorus cast irons and hematite pig-irons the standard wet oxidation method given may be used with either the volumetric or the various alternative gravimetric finishes, varying amounts of sample being used according to the percentage of phosphorus expected, but in the presence of appreciable amounts of arsenic and/or titanium it is probably better for accurate work, and especially where it is necessary to check any series of results on this class of material, to rely on one of the longer methods with direct separation of arsenic and/or titanium.

The arsenic may be separated either as chloride or sulphide. In the first case the arsenic is removed in the form of volatile arsenious chloride, as well as arsine, the evolution being carried out by means of zinc and hydrochloric acid. In the second method the arsenic is removed directly as arsenious sulphide As_2S_3. In both cases it is advisable to precipitate the phosphorus, after the removal of arsenic, by means of an acid nitromolybdate solution instead of adding neutral ammonium molybdate to the acid solution. The estimations are finished in the usual manner either volumetrically or gravimetrically.

Titanium is usually eliminated by separation as insoluble sodium titanite from fusion of the siliceous residue with sodium carbonate.

The author prefers the removal of the arsenic as sulphide because in this way the extra complication involved by the presence of zinc salts is avoided, while the removal of the arsenic is always complete by this method. In samples of hematites and the like, containing titanium, the removal of this element may be effected in the same portion.

(*To be continued.*)

Publications Received.

The Prince at Colvilles'.—This is a well-illustrated brochure giving the story of the recent visit of H.R.H. the Prince of Wales to the Clydebridge Steel Works of Messrs. David Colville & Sons, Limited.

Direct Production of Steel.—The Anglo-American Steel Company, Limited, 66, Victoria Street, London, S.W.1, have sent us a copy of a brochure entitled "The Carsil Process." Many tests are given of steels made from an iron sand base in the form of test sheets prepared by the Sheffield Testing Works, Limited. Whilst the book is of considerable metallurgical interest we suggest that more information about cost of production would render the book more acceptable. The tests do, however, show that excellent steel can be made from titaniferous iron sands when reduced and treated in the electric furnace under skilled metallurgical control. The only real reference to costs that we can find is contained in a report from Dr. Rogers, who says "it (the Carsil Process) does not present any special defects in operation such as would unfavourably affect the costs of production," and "there is convincing reason to believe that the process will be particularly economical in commercial operation." In view of the above we reiterate that lack of definite operation costs, even though they be from an experimental plant, is to be deplored. We would even forgive the insertion of synthetic curves derived therefrom with extrapolation to include gargantuan output. After careful perusal we feel convinced that many high quality steels have been made by this process, and we await with interest the production of figures to enable the metallurgist to say with some degree of certainty that the method can be carried out under commercially economic conditions, either in Sheffield, where skilled metallurgical control is available and general costs appreciable, or in "some wild and woolly west," where scientific erudition is at a premium, but iron sand and electricity are "going begging." The brochure contains 32 pages, but the illustrations lose something of their value through the use of coloured printing ink and paper.

Effect of Melting and Pouring Conditions upon the Quality of No. 12 Alloy.*

By T. W. Bossert, New Kensington, Pa.

It is a foundry maxim that metal should be poured at the lowest temperature possible for running a particular casting, and that, subject to practical limitations, the temperature of the metal during the melting should not be permitted to rise above the pouring temperature. The value of the above rules has been proved time and again in aluminium founding, yet to-day too many foundries pay little attention to the matter of temperature control, and thus neglect one of the keys of successful, continuous operation.

The effect of pouring temperature upon the mechanical properties of sand-cast aluminium alloys has been studied by many investigators,† and references in the literature may be found which recognise that desirable mechanical properties are linked with fine or "close" grain structure in the casting. The presence of a coarse structure and the presence of such defects as draws are always objectionable, yet little exact information is at hand regarding their relation to melting and pouring conditions, as well as upon the relationship existing between crystal structure and the drawing tendency.

The importance of the above factors, namely, melting and pouring conditions, especially in the case of No. 12 alloy (the commercial 8 per cent. copper-aluminium casting alloy) has been recognised for some time, and active steps have been taken in the laboratories of the Aluminium Company of America to obtain more exact information regarding their effect upon the quality of No. 12 alloy castings.

Consideration of the conditions ordinarily met with in the foundry indicated that the following factors should be studied:—(1) Melting temperature; (2) pouring temperature; (3) soaking time in furnace; (4) history of material prior to final remelting.

It has been shown that, while drawing can to a large extent be minimised by changes in moulding method, yet the drawing tendency increases with the coarseness of the crystal structure in the casting. Whenever a coarse crystal structure is produced in a casting, the tendency for drawing is invariably stronger than is the case when the crystal size is fine. Factors causing a coarse structure, and therefore the tendency for drawing, are excessive melting or pouring temperatures, and soaking of the metal in the molten condition. These same factors, furthermore, tend to increase the tendency of the casting to crack. It has also been found that these effects due to improper temperature conditions can be eliminated by a subsequent remelting.

The general rules regarding melting and pouring temperatures have therefore been found to hold, and the results have further emphasised the necessity for accurate temperature control, both at the furnace and at the mould.

Experimental.

Materials Used.—No. 12 alloy used was of two kinds, namely, (1) commercial No. 12 alloy ingot, and (2) No. 12 alloy made from commercially pure aluminium (99.2 per cent.) and 50-50 per cent. aluminium-copper alloy, the metal being cast into sand moulds without intermediate pigging and remelting. In the cases where high silicon or iron contents were desired, 15 per cent. silicon and 5 per cent. iron hardeners were employed.

Preparation of Alloys.—The metal was melted in plumbago crucibles, and the melting operation carried out in an electric resistance furnace equipped with automatic temperature control. Accurate check of the metal temperature in the furnace was obtained by means of an iron constantan thermocouple immersed in the bath, and the temperature of the metal immediately before pouring was determined by means of a quick reading, open-end chromel-alumel thermocouple.

Manner of Testing.—The plan of this work required tests for two effects, namely, draws and crystal size.

In order to avoid confusion, a definition of a "draw," as differentiated from a "shrink," is necessary. A "shrink" is generally a smooth depression on the surface of a casting due to unequal cooling or to insufficient feeding during solidification. A "draw," on the other hand, is that defect, occurring generally in the corner of a casting, or in a relatively thick section adjacent to thinner sections, which appears as worm-like channels on the surface of the casting. These channels may be quite deep, so that the uneven surface produced cannot be removed by the ordinary amount of grinding and polishing. It is thought that the draws are produced during solidification by normal segregation occurring in alloys, coupled with insufficient feeding to the heavy section, by the adjacent light sections. The low melting constituent (consisting of an alloy approximately the eutectic composition—33 per cent. copper—in No. 12 alloy) is drawn from the surface of the casting to the interior, thus leaving series of fine channels around the crystals formed early in the process of solidification. Thus draws can be produced by any alloy which freezes over a range of temperature, and which shrinks upon solidifying.

In order to fulfil the purpose intended in this work, it was necessary to obtain a pattern for a sand casting containing sections prone to develop draws, but such that a perfect casting could be poured under correct conditions of metal treatment. A simple frying-pan pattern was found which produced a perfect casting under such correct conditions, and which produced castings containing draws under other conditions. In all cases the arrangement of gates, moisture of sand, and all variables relating to the moulding were maintained as nearly constant as possible. Thus the only variables existing were those imposed on the metal before it was poured into the mould.

The same casting used for the detection of draws was also used to study crystal size, thus making it possible to determine the relationship existing between draws and crystal size. Crystal size was determined by etching the surface of the casting with a suitable reagent to develop the structure.

Effect of Melting Temperature.

In this phase of the work melting temperatures ranging from 715 to 925 deg. C. were employed. It was found by trial that 715 deg. C. was the lowest pouring temperature at which the metal completely filled the mould, with the arrangement of gates used.

In order that all other variables concerned with the treatment of the metal might be maintained constant, all specimen castings were poured from the same original melt. During the heating of the melt to the maximum temperature, 925 deg. C., metal was removed at the desired temperatures up to 925 deg. C., and poured when it had cooled to 715 deg. C. This pouring temperature was maintained constant throughout this series.

An increase of melting temperature above 760 deg. C. resulted in a definite regular increase of crystal size. The same effect was found as regards draws, that is, increase of melting temperature caused an increase in depth and number of draws, as well as in the area over which the draws extended. The crystal size at 715 deg. C. and 760 deg. C. was fine and eutectic draws were absent. These temperatures, therefore, can be regarded as safe temperatures to which to melt the metal. Temperatures higher than 760 deg. C. need not be used for pouring the casting under consideration, and therefore should under no circumstances be sanctioned. In certain cases it might seem impossible to operate successfully when melting temperatures below 760 deg. C. are observed. In the majority of cases, however, pouring temperatures can be materially reduced by changing the gate so as to allow the metal to enter the pattern cavity at a number of points. Otherwise a slightly less desirable crystal structure and danger of drawing in the casting must be accepted as a result of increasing the melting temperature to the required value.

The important point to bear in mind regarding the effect of melting temperature is that once metal has been heated above the required temperature it has suffered certain detrimental effects which are apparent in the casting. Simply cooling the metal down to the correct temperature does not correct the damage done.

Effect of Pouring Temperature.

The results just given would lead one to suspect that increase of pouring temperature, which automatically carries with it an equal increase in melting temperature, would have a harmful effect upon the metal equal at least to that caused by raising the melting temperature. Whether there is a further effect due to higher pouring temperatures, *i.e.*, due to not cooling the metal to the proper temperature, was ascertained by the following experiments:—

Test castings were poured at temperatures from 715 deg. C. to 925 deg. C., the metal for all castings being taken from the same melt, and the melting temperature for each successive condition being at no time more than 5 deg. C. above the pouring temperature. The test was carried out by heating the metal to 715 to 720 deg. C., pouring suitable castings at 715 deg. C., then raising the temperature to 760 to 765 deg. C., pouring castings at 760 deg. C., and so on to 925 deg. C.

There was a pronounced coarsening of grain with increase of pouring temperature, and drawing appeared in the casting poured at 760 deg. C. which rapidly became more pronounced as the pouring temperature was increased.

A comparison between results obtained in the two series of tests immediately points out that further detrimental effects in addition to those caused by high melting temperatures, are caused by high pouring temperature. *For a given melting temperature*, above 715 deg. C., the grain size is definitely coarser and eutectic drawing more pronounced in metal poured at that temperature than in metal cooled to the proper pouring temperature. It is important to note that eutectic draws appear plainly in the specimen casting poured at 760 deg. C.

Control of pouring temperature has been shown to be quite as important as control of melting temperature. In the first place, a high pouring temperature is evidence of a high melting temperature, the evils of which have been discussed. Then, the high pouring temperature in itself tends to increase the formation of draws and a coarse structure, so that the effect of a high pouring temperature is markedly more harmful than that of a high melting temperature alone.

Effect of Soaking.

On a number of occasions inconsistent results were obtained on metal which had been allowed to remain in the furnace for some time in the molten condition. The inconsistencies generally occurred when higher temperatures were being employed, indicating that possibly soaking at high temperatures had an effect upon the metal not produced by soaking at normal temperatures. The above indication was proved the correct one in the following manner.

Two series of soaking tests were carried out by melting sufficient No. 12 alloy for pouring three sets of castings. The first set was poured as soon as the metal temperature had reached the desired temperature, the second set was poured at the soaking temperature after a 4-hour soak, and the third set was poured after a 24-hour soak. The first series was soaked and poured at 715 deg. C., the second series at 785 deg. C.

Close examination of all castings made from metal soaked at 715 deg. C. revealed no differences in crystal structure. No draws were detected in any castings. Metal not soaked and soaked at 4 and 24 hours at 715 deg. C., gave no indication that the treatment had been detrimental.

* A Paper presented to the Philadelphia Meeting of the American Foundrymen's Association. The author is on the staff of the Technical Direction Bureau, Aluminium Company of America.

† Gillett, H. W., "Influence of Pouring Temperatures on Aluminium Alloys," Eighth International Congress of Applied Chemistry. Vol. 2, 1912, pp. 105–112.

A sharp increase in grain size and in eutectic drawing, however, was noted as the soaking time was increased, and was pronounced when 785 deg. C. was the soaking temperature.

With the above evidence at hand the cause of inconsistent results sometimes encountered when working at the higher temperatures was plain, especially since the increase in grain size after 4 hours' soaking was as indicated.

The fact that soaking at elevated temperatures produced detrimental effects in a relatively short time, while a low temperature soak of 24 hours' duration produced no such effects, again argues for low melting temperatures. As a general rule, soaking metal for long periods of time is not to be recommended, but when this procedure cannot be avoided it is most important that the metal temperature be kept as low as practicable lest harmful effects result.

Effect of Previous History of Metal.

The question naturally arises whether and how metal which has been damaged by any of the treatments described above can be corrected. The detrimental effects of high temperature and soaking treatments have been demonstrated, so that these methods cannot be used to correct effects caused by them.

It has been found that complete correction of the effects described in this Paper can be brought about by casting the damaged metal and remelting. Metal which has been remelted to 925 deg. C., and poured at 925 deg. C., which procedure is one of the most damaging conditions that can be imposed on it, can be made normal by again remelting.

In the second remelting control of melting and pouring temperatures must not be neglected. If the metal is again remelted and poured under improper conditions the metal will again be damaged; in other words, remelting is effective in removing the detrimental effects of the preceding melting, etc., but does not guarantee against damage if the metal is again improperly handled.

A discussion of the effect of previous history of the metal upon the quality of the casting also raises the question whether the quality of the product produced from the commercial No. 12 alloy ingot differs from that produced by direct alloying of the constituents of the material without interposition of the pigging and remelting operations. Providing the melting and pouring conditions previously discussed are met, no difference in quality of castings made by the two methods under consideration will be found.

Relationship between Crystal Structure and Drawing and Cracking Tendencies

Throughout this discussion the simultaneous occurrence of coarse crystal structure and drawing, both of which are objectionable, has been pointed out. It has been clearly shown that a coarse structure results from high temperature melting and pouring, and high temperature soaking of the molten metal. Drawing in a casting can be minimised by changes of gating, but the tendency for drawing is invariably present in a casting whose structure is coarse, and which has, therefore, been treated in one of the ways previously described as causing such a structure. It has also been found that the tendency of castings to crack increases under the same conditions as produce a coarse structure and drawing. This point is very important, as oftentimes cracking can be prevented by observing proper melting and pouring conditions.

General Applicability of Conclusions.

The general effects described in this Paper are applicable to all No. 12 alloy castings. The actual temperatures below which satisfactory castings are produced, and above which unsatisfactory castings result, apply only to the test casting used in this work. The temperature range within which satisfactory results are obtained depends to a large extent on the casting and will be wide in some cases, so that satisfactory castings can be poured at temperatures appreciably above 760 deg. C., while in other cases the range will be very narrow.

The general effects of temperature and time, as reflected in the quality of the resultant casting, are not altered by variations in iron or silicon content from 0.5 to 1.5 per cent. Variations of these constituents in No. 12 alloy are effective in altering to a slight extent the degree of drawing and the absolute crystal size, but they have not been found to change the general effects due to temperature and time described here.

The normal variations which occur from lot to lot of the same metal may also alter somewhat the degree of drawing and absolute crystal size, but the general effects due to temperature and time are not altered by these variations.

Thus the effects of melting and pouring conditions are not influenced by the casting to be made, the impurity content of the alloy, a particular lot of metal, or the previous history of the metal.

General Conclusions.

The following facts have been established as a result of the work described in this Paper.

1. There appears to be a definite relationship between crystal size and drawing, in that a coarsening of crystal structure indicates increasing tendency for draws to appear.

2. With constant pouring temperature, increase of melting temperature produces increase of crystal size and causes drawing.

3. An increase in pouring temperature results in more pronounced drawing and coarser crystal structure than does an identical increase of melting temperature alone.

4. Soaking tends to cause formation of draws and coarse crystal structure. This tendency is much more pronounced at high than at low soaking temperatures.

5. The same conditions which cause coarse crystal structure and drawing also tend to promote cracking of the casting.

6. Remelting has been found to remove the detrimental effects, as regards drawing, cracking, and coarse structure, produced by the previous melting.

7. The basic effects described are not altered by change of pattern, variations in impurity content, or normal variations encountered from lot to lot of metal, and can be produced on metal remelted once or remelted any number of times.

Sacrificing Quality to Economy.

By J. McLachlan.

The writer was shown a number of castings by a machine-tool maker recently that were not wasters, but certainly did no credit to the foundry from which they came. The foundry was blamed, of course, but it is probable that the customer was not prepared to pay a price for good work. Buying castings in the cheapest market is not always good policy.

More often than not, even when castings are inspected before they go on the marking-off table, it is in the machine shop as well as the erecting shop that objectionable castings are discovered. A casting that has cost little for pattern-making and moulding may be expensive to machine. A "rush" job may be hurried through the pattern shop in record time, and a casting as quickly produced in the foundry, and then machining may be a slow process. Time is also saved at the marking-off table when a casting approximates closely to the drawing with uniform machining allowances.

Admittedly the expression is often used that a job is good enough for the purpose, and a one-off job is invariably urgently wanted, and speed may be more important than quality. It does sometimes happen also that the practice of discriminating between first-class work and the other kind has the pernicious effect of uniformly lowering the quality of all work produced in course of time. The opinion was expressed to the writer once, by an old iron foundryman who had a good jobbing business, that it is not safe for a foundry to make two qualities of castings, and, in some measure, he was right. Castings may be sound, but lack a good surface. Some moulders can discriminate with great skill between the parts of a casting that should have a good skin, and the other parts that do not matter. Other moulders, unfortunately, lack that skill. Further, there is always a temptation when a customer accepts work that is not too good, to deliver the same class of work to him again. There is much to be said for the practice of making no other than well-finished castings, but the average foundry has to adapt itself to customers' requirements.

We have heard it said that it is castings that are wanted and not patterns, and for this reason many firms consider that any old pattern from which a casting can be made is quite good enough. They may save time and timber in the pattern shop by supplying boards to the foundry instead of a pattern and corebox, but as to whether the cost of the casting will be greater or not is quite beside the point. Even when a pattern is supplied, it may be quite unsuitable for the production of a good casting at a reasonable cost. There may be endless making up after it has been withdrawn from the sand, and drawbacks may also have had to be made which could easily have been avoided by the patternmaker. It is a common experience for foundries to get patterns sent them which might have been made by cabinet makers and finished by french polishers, yet they may be exceedingly bad patterns without taper or practical methods of dealing with loose pieces. Varnish, paint and leather fillets will not change a bad pattern into a good one.

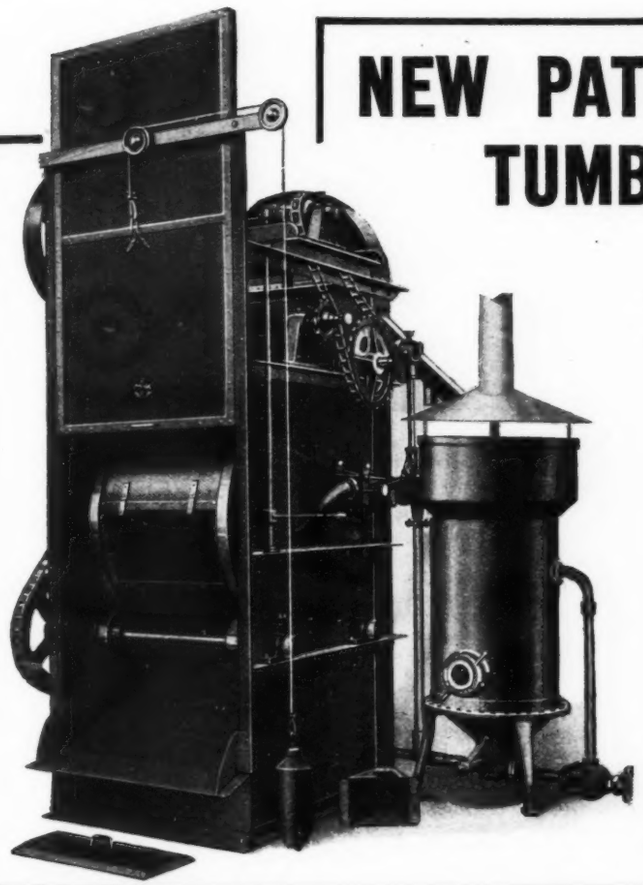
Utility of Skeleton Patterns.

Skeleton patterns are more suitable for certain work than solid patterns, but it is not economy for the pattern shop to supply the foundry with skeleton patterns and coreboxes or with strickles when castings could be better and more cheaply made with block patterns and coreboxes. Skeleton patterns are only economical when they can be justified by consideration of foundry costs, and the same may be said of sweeping boards as alternatives to patterns. No pattern work is cheap that causes moulding cost to be high. A pattern maker is doing a disservice to his firm when his only concern is to keep his departmental costs down. There are occasions when it is quite reasonable to make a cheap pattern that is "good enough for the purpose," but there is grave danger, if resultant castings are fairly good, that all the patterns may be made of the same quality, and a wise foreman patternmaker fights against this tendency. A good pattern usually pays for itself.

There is the important question of timber. The writer can recollect a set of large cylinders and a bedplate being made of spruce. Two castings were wanted from each pattern. When the patterns were being reassembled for the second casting, it was found necessary to thicken up flanges and other parts, as the distances between centres had grown, due to the timber swelling. There was a very considerable difference in the weights of first and second castings, and the machine shop charges for the latter were much heavier. The initial saving of using spruce instead of yellow pine was far more than swallowed by these items, and also by the patternmaker's time in the foundry.

Yet even when good patterns are supplied to the foundry, effort is not always strained to supply good castings. In a jobbing foundry where castings of every kind are produced, it is not possible to standardise practice or to use metal that is the most suitable for every purpose. But endeavour should be made to produce good castings every time, and, if very great care is not taken in discriminating between castings of the sash-weight variety and quality work, there will be no repeat orders. In specialist foundries, where only one class of castings is made, there is not, of course, the same temptation to produce bad work. When a foundry accepts work at an unremunerative price, it suffers in two ways, because not only is there a direct loss—or no profit on the transaction—but there is no repeat order.

A mass meeting of employees of Messrs. Spencer's steelworks, Newburn-on-Tyne, last week decided to issue a broadcast appeal to financiers to provide £50,000 for the purchase of the business and £25,000 for working capital in order to prevent the works being dismantled. The employees offered to invest 5 per cent. of their weekly earnings in the undertaking if the appeal is responded to. The works have recently been sold to Messrs. Thos. W. Ward, Limited, Sheffield, by Mr. R. S. Dagleish, who had failed to find financial support in an endeavour to keep the works going.



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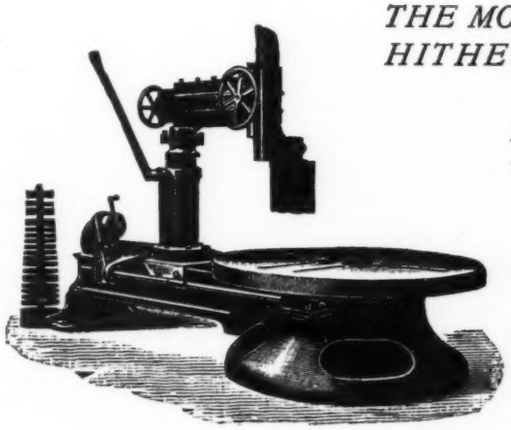

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Theory and Practice.

To the Editor of The Foundry Trade Journal.

Sir,—Under the above title Mr. E. Adamson has expressed his views on our Paper on the graphite in grey cast iron.* He considers it as an interesting illustration of theories which can be formed, based on laboratory work which are not applicable in bulk. The discussion of Mr. Adamson, emanating from entirely false premises, being likely to mislead those foundrymen who have not access to the original and complete Paper, a rectification is necessary.

The Paper aims at giving foundrymen a coherent account of the rationale of the graphite precipitation, pointing out methods for systematically influencing the graphite precipitation and explaining the relations between the shape and distribution of the graphite and the mechanical properties of cast iron.

Though especially in the latter part of the Paper there may be some experiments that were necessary to complete some of the series, as, for instance, to study some special type of graphite-precipitation or the influence of a more favourable shape of the graphite, there is no suggestion that anybody should use such experiments on a practical scale, where the influence of mass obviously precluded its commercial application.

Referring to the objections of Mr. Adamson in particular we would like to make the following observations.

We have concluded from our experiments that white iron, when alloyed in the molten state, will give better properties than a graphitic iron, that is melted without superheating. These experiments could only confirm the practical value of a method that was successfully developed in Germany many years ago. We have not originated this excellent method ourselves.

It is clear that Mr. Adamson has not completely understood the intention of the comparative experiments with sand cast and annealed chilled-cast from the same heat. The experiments should make it clear that a very fine graphitic formation can influence the strength far more favourably than the metallic matrix. We think this is clearly proved by the fact that samples of the same dimensions with finely-distributed graphite showed far better properties than the samples with a pearlitic matrix and relatively coarse graphite in spite of a more or less ferritic matrix of the former.

All other variables that Mr. Adamson may consider, are quite negligible compared with the above-mentioned factors.

That the chilled cast should be ferritic seems to Mr. Adamson "to upset natural laws applied to chill." To this we desire to point out that our chilled cast was, of course, quite white, *i.e.*, ledeburitic immediately after casting, but Mr. Adamson has evidently overlooked the fact that the samples after cooling were annealed for six hours at 850 to 950 deg. C., and cooled very slowly in the furnace. The conclusion that we have drawn from this experiment clearly shows the direction which the practical men should follow in order to obtain a cast iron with the best possible properties.

The apparent contradictions between theory and practice, that Mr. Adamson thinks could be drawn from our paper, are probably derived from the fact that he has not been able to get a clear view of its aim from the short extract that was published in The Foundry Trade Journal. This will confirm the rule that it is very dangerous to judge a paper only from superficially reading a short extract.

The frivolous criticism of our paper gives us the impression that it is the result of a preconceived opinion of Mr. Adamson as against laboratory experiments. The conditions of our experiments were kept as closely as possible to bulk practice: the weight of a sample was 30 kg. (66 lbs.), the test bars were of the same dimensions as those used in practice, the results were therefore directly comparable without further question.

Moreover, we would like to remind Mr. Adamson of the fact that some of the most important improvements of high-quality cast iron in the last years in Germany are due to laboratory experiments on a very small scale. To make these theoretical results applicable to practical work, it is of vital importance that foundrymen should accept the results of such experiments with a full appreciation of mass effect.—Yours, etc.,

P. Bardenheuer and K. L. Zeyen.

K.W. Institut für Eisenforschung,
Düsseldorf. October 9, 1928.

[This letter is of considerable interest, in view of the fact that the November meeting of the London Section of the Institute of British Foundrymen is to be devoted to a discussion on the Paper. The Branch has been fortunate in securing Mr. John Shaw as the opener.—Editor.]

* Die Giesserei 15 (1928), pp. 354-393, 411-420, abridged translation in the Foundry Trade Journal 39 (1928), August 23, pp. 133-136.

Institute of British Foundrymen.

NEWCASTLE BRANCH.

The first meeting of the Session of the Newcastle and District Branch was held on September 20, 1928, in the Neville Hall, Newcastle-upon-Tyne, when Mr. Colin Gresty delivered his presidential address on "Progress in Ironfoundry Work," which was printed in our last issue.

Before reading his address, Mr. Gresty announced that medals which had been presented in memory of the late Mr. John Buchanan, one of the early Presidents of the Institute, would be awarded annually to members of Junior Sections, the conditions governing the award being read by the Hon. Secretary, Mr. F. Sanderson. Mr. Gresty also drew the attention of members to the visit of the Junior Section to the Beehive Foundry coke plant of the Priestman Collieries, Limited, at Rowlands Gill, by the kind invitation of the Company, who had also kindly offered to provide transport from Newcastle to Rowlands Gill, and he appealed to all Senior members to ask as many boys as they could to attend the visit.

Mr. Gresty said they would have seen from the circular announcing that evening's meeting that the October meeting would take the form of a competition. Members of the Branch were invited to submit short Papers of 750 to 1,000 words dealing with any subject allied to the foundry industry. The Papers would be read at the October meeting and a vote taken to decide the best contribution, the names of the authors being kept strictly confidential until the conclusion of the voting. A small prize would be awarded to the author of the winning Paper, which would then be opened for general discussion. It was hoped that the competition would broaden the number of Paper writers and give a chance to those members who had not as yet read Papers before the Branch.

It was also announced that Mr. W. H. Poole, member, of Keighley, had been awarded a Diploma for his Paper on "Cupola Practice," which was delivered before the Branch last Session.

The 0.5 per cent. P. Danger Line.

Mr. R. O. Patterson (a Past-President of the Institute) said he had found an immense benefit by having even a small laboratory in their foundry. They did not, of course, set out to be highbrow chemists, but they had chemists who analysed waster castings, and also good castings, and it was enlightening as to what a fund of knowledge could be obtained from a comparison of the results. That was about as far as they went with laboratory control, but it had been admittedly worth while. They had made a line in heat-resistance castings, and Mr. Fred. Cook, who had recently given a Paper before them, had more or less warned them to keep away from 0.5 per cent. phosphorus in that type of iron. It had been rather interesting that a few days after Mr. Cook had given his lecture one of their customers had complained that castings supplied had not stood up to the heat very well, and when those castings were tested it was found that they contained exactly 0.5 per cent. phosphorus. Mr. Gresty had mentioned the economies that could be made in a foundry, especially with sand-handling plant. Some years ago they had had four men who shovel-mixed and threw into a mill all sand required, about 60 tons per day, and he was not satisfied. One day he had seen a concrete mixer at work where a new road was being laid, and he had got the idea that it could be used for sand mixing. He had bought one, and now one man and a boy did the 60 tons per day with the assistance of a rotary riddle. There was one thing about sand conveying which applied particularly to that district, and that was that Erith sand was difficult material to work automatically, and all the machines had to be continually cleaned out because the sand clung to them. He rather fancied that in the United States they did not have that trouble, although he did not know the explanation. It was probably because Erith sand had much more bond than was actually necessary. He was about to try an experiment shortly with some synthetic sand with a base of silver sand, and he hoped to have better results that way. He agreed with Mr. Gresty that cupola practice in this country left a lot to be desired in many places. He believed that with systematic observation of the cupola they could make immense progress. He thought that they had benefited a great deal since they had studied Mr. McLain's work, and it had been well worth while.

Mr. Thomas, a visitor, said that Mr. Gresty had particularly mentioned in his address high-grade cast iron for high-tests, iron such as is used for Diesel engine and superheater steam work. He had stated that risers and feeders generally should be of a standard size, and that pouring speeds ought to be expressed as so much weight per unit of time instead of fast or slow, and he entirely agreed with those statements. He would be greatly interested to know what Mr. Gresty considered a good pouring temperature for high duty cast iron, which was a point upon which he had not touched.

Mr. W. J. Paulin said that although they did not have a laboratory they did have analyses made, and he had found a distinct advantage from mixing steel with iron. Every foundry had to use a large quantity of scrap, and it was impossible to examine every lot of scrap by analysis, and the test would have to be made by fracture. They obtained quite good results, but the iron would not do of course for such high-class work as Diesel engines. He had visited a well-known foundry in Scotland, and he had been struck with the great advance in the quality of the iron. He could remember some old cylinders which took a great deal of breaking, but they were made of cold blast iron. They must not fail to give the credit of the present-day iron to the research work of the metallurgical chemist.

Mr. R. J. Shaw, referring to Mr. Patterson's remarks concerning Mr. Cook's warning against 0.5 per cent. phosphorus and his own difficulty with a defective casting, said that he was not surprised that Mr. Patterson's casting had been defective if phosphorus had been present to any extent. For heat-resisting castings he thought phosphorus should be kept very low. He did not think Mr. Cook intended his remarks to be taken with reference to heat-resisting castings. The chief quality of cold blast iron was that it contained low carbon, but a reduction in carbon was nowadays obtained by using steel.

Mr. Paulin asked if they were very clear as to what Mr. Cook had said. He had been discussing the question of cylinder iron which would wear well, and he had discovered that when there was 0.5 per cent. phosphorus the iron wore very rapidly. He had then made a cylinder with a phosphorus content of 1.3 per cent., which was enormously high, and the cylinders were running yet.

Mr. Patterson said that he thought that Mr. Cook's point was that they must keep away from phosphorus between 0.4 and 0.6 per cent. Above 0.6 or below 0.4 per cent. phosphorus was quite all right. He could not be sure, however, whether Mr. Cook was talking of heat-resisting iron or not.

More About Low Waster Losses.

Mr. Allan said that he had recently been visiting a foundry where he was told that they had only had one bad casting in three and a half years. He had discovered, however, that all the castings they made were the ordinary castings used about their own foundry and blast furnace. Mr. Gresty had said that experience was the basic factor in all progress, and he himself thought that practical experience coupled with an open mind with regard to all scientific research was the vital point. He was afraid that conservatism in the foundry was what

(*Continued on page* 292.)

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Trade Talk.

British Insulated Cables, Limited, Prescot, have received an order from the Post Office for 32 miles of 160/40-lb. telephone cable.

It is announced that the Avondale Tinplate Company, Limited, of Pontnewydd, are putting down six new tinplate mills of an American type.

The imports of foreign iron ore at the Prince of Wales Dock, Workington, for the three months ended September, amounted to 24,480 tons, compared with 23,400 tons in the previous quarter.

Messrs. Gjers, Mills & Company, Limited, have decided to light up in the first week of the new year two of the five blast furnaces at their Ayresome Ironworks, Middlesbrough, all of which are at present idle.

The steamer "Yser," which arrived at Cardiff recently with a cargo of iron ore for Messrs. Guest, Keen & Nettlefolds, Limited, discharged 2,400 tons in an actual working time of 19 hours, giving an average discharge of 179 tons per hour.

It is announced that the erection of the Chemical & Metallurgical Corporation's lead plant at Runcorn is nearing completion, and will, it is expected, be in partial operation in the course of a few weeks and in full operation before the end of the year.

The Yorkshire Engine Company, Limited, Sheffield, have delivered three tank locomotives to the London and North-Eastern Railway for work on the Metropolitan section, and are engaged on the construction of six similar engines for the North British section.

Four vessels with an aggregate tonnage of 16,880 were launched from Sunderland shipyards during September, making the total output for the nine months of the present year 41 vessels of 171,009 tons gross, compared with 21 vessels and 83,705 tons gross in the corresponding period of 1927.

Messrs. Thompson Bros. (Bilston), Limited, engineers and tank makers, have inaugurated a co-partnership scheme. Two of the workpeople have been appointed directors to assist the board, with eight deputy directors. There are several hundred employees, and the scheme provides for the creation of employee shares, for distribution according to length of service.

The Borough Road Foundry, Sunderland, which has been in existence since 1855, is being offered for sale as a going concern by the owners, Messrs. John Saunders, Limited, failing which it will be closed down. When working to full capacity, the foundry employed 200 men. Last year about 120 were regularly employed, but latterly the number has been considerably reduced.

An extraordinary general meeting of Allen-Liversidge, Limited, was held on October 8 in London to consider proposals for increasing the capital of the company to £600,000 by the creation of 100,000 6½ per cent. cumulative preference shares of £1 each, to rank *pari passu* with the existing 6½ per cent. cumulative preference shares. A resolution embodying the proposals was carried unanimously.

Shareholders of Messrs. Crompton Parkinson, Limited, electrical engineers and manufacturers, have been informed by the chairman that arrangements have now been completed whereby a block of the deferred ordinary shares are made available for purchase by holders of the preferred ordinary shares. The whole of these shares have been held privately by Mr. F. Parkinson and Mr. A. Parkinson.

Mrs. Wilfred Ashley, wife of Lt.-Col. Ashley, Minister of Transport, formerly declared opened on Monday the new hydro-electric works of the North Wales Power Company, Limited, at Maentwrog. There is a fall of 650 ft. from the reservoir to the power house, in which are installed three turbines of 9,000 h.p. each, linked with generators each of 6,000-kw. capacity. The scheme has cost £750,000.

Representatives of the Executives of the Transport and General Workers' Union and the Workers' Union met in conference in London on October 9, further to discuss the scheme under which the two unions will be amalgamated. An agreement was reached, and the members of both unions will ballot on the scheme. If approved, the fusion will create the largest single organisation, apart from federations, in the country.

After having been idle since last January, the South Yard at Belfast of the shipbuilding firm of Messrs. Workman, Clark (1928), Limited, is to be reopened, following new orders. Messrs. Andrew Weir & Company have placed an order with the builders for two more motor ships of about 10,000 tons each, making eight vessels in all to be built. The slipway for a new Ellerman liner is ready, and a sludge steamer will be launched shortly.

Personal.

Mr. H. G. Somers has relinquished his position as foundry manager to Messrs. W. E. Horsman, Son & Company, The Mitcham Foundry and Iron Works, Eveline Road, Mitcham, Surrey.

Sir David Milne-Watson, and Mr. Robert Whyte Reid, have been appointed members of the Advisory Council to the Committee of the Privy Council for Scientific and Industrial Research, in the place of members who have retired on the completion of their terms of office.

Mr. Howell R. Jones, a director of Messrs. Guest, Keen & Nettlefolds, Limited, and general manager of the company's works and collieries at Dowlais, intimated at a meeting of the board recently that he had definitely decided to retire from the general managership. Mr. Jones tendered his resignation two years ago after completing 50 years' association with Dowlais, but was persuaded by the late Lord Buckland to continue. The directors decided that Mr. W. Simons, at present manager of the Cardiff works, should also assume management of the Dowlais works. Mr. Howell Jones, who will retain his seat on the board, was born at Dowlais in 1860, and served his apprenticeship at the Dowlais Collieries, becoming, later, manager of one of the pits. A few years afterwards he was appointed deputy colliery agent, and subsequently agent. He was then appointed general manager of the Dowlais works and collieries. Mr. Jones was Vice-Chairman of the Monmouthshire and South Wales Coalowners' Association in 1917, and in the following year was elected Chairman of that body. Mr. W. Simons commenced his business career with the Blaenavon Company, and subsequently held appointments with the United Steel Companies, the Shelton Iron, Steel & Coal Company, and Messrs. John Summers & Sons. He took up his present appointment at Cardiff in 1926. Mr. Simons is a director of Messrs. Guest, Keen & Piggotts, Limited, the Orconera Iron Ore Company, Limited, the C. W. Engineering Company, Limited, and the Cambrian Wagon Company, Limited.

Obituary.

Mr. M. G. Cohen, chairman of Messrs. George Cohen, Sons & Company, Limited, iron, metal and machinery merchants, of London, and a director of several other companies, died in London recently.

Mr. John Eastwood, of Messrs. John Eastwood & Sons, engineers and ironfounders, Etruria, Stoke-on-Trent, died recently at Wolstanton, at the age of 65. He had been the principal of the firm for the last 35 years.

We deeply regret to record the death of Mr. C. T. Shedden, who was for nearly 30 years attached to the editorial staff of our contemporary, "The Iron and Coal Trades Review," and during the past two years was editor of that journal. Mr. Shedden died last Friday morning.

Mr. William H. Kitson, J.P., founder of the Leeds Wheel & Axle Company, Limited, died at Kirkstall last week in his ninetieth year. He was the patentee of the railway wheel on which the business was founded, and was connected with the firm up to his retirement in 1921.

We regret to announce the death of Dr. Ing. Kurt Sorge, which took place on September 9, 1928, at Berlin, at the age of 73. He was the hon. president of the Federation of German Industries, and for very many years a director of the firm of Krupps. He was keenly interested in social-political life, in which he took a prominent part. After the war the attention of the public was specially drawn to his great administrative powers. He possessed a strong personality, and was successful in forming the Federation of German Industries, of which he was president for several years. The service he rendered during Germany's most difficult crisis following the war was much appreciated, and on his retirement from this office the dignity of honorary president was bestowed upon him.

New Companies.

Charles E. Hart, Limited.—Capital £5,000 in £1 shares (3,500 5 per cent. cumulative participating preference). Engineers, iron and brassfounders, etc. Solicitors: D. Jeffrey Aitken & Company, 144, West Regent Street, Glasgow.

Mona Copper Company, Limited, 46, London Wall, E.C.—Capital £30,000 in 100,000 5s. and 100,000 1s. shares. Directors: Brig.-Gen. Sir O. de l'Epee Winter, Sir Wm. B. H. Hughes-Hunter, R. Ballantine, B. A. Wightman, H. T. Durrant and J. M. Reid.

Manchester Association of Engineers.

The opening meeting of the seventy-fourth session of the Manchester Association of Engineers took place last Thursday at the Engineers' Club, Albert Square, Manchester. The Constantine Gold Medal was presented to Mr. A. H. Goodger for his Paper on "The Influence of Metals on Workshop and Design Problems," and the Butterworth Gold Medal to Mr. Julius Frith for contributions to the discussions during the past session.

In the course of his Presidential Address, the President, Mr. William G. Gass, said that financial problems did not enter sufficiently into engineering training. Engineering was a fascinating occupation in itself, and there was a tendency for engineers to forget that however interesting was the construction of machines, those machines had to be sold at a price which would show a profit. This fact was frequently learnt late in their career as a result of bitter experience.

In all engineering works there was a section of workers who were non-producers but who were absolutely essential to the business. The wages or salaries of these persons must be covered in the cost of production. Overhead charges were often imperfectly understood by employees, and the commercial side, therefore, should be part of the training in technical schools and colleges.

Dealing with workers' suggestion schemes, Mr. Gass said that employees did not and could not afford to ignore such suggestions; it was obvious, however, that the workman with fertile ideas frequently rose to the top, and improvements more frequently came from the suggestions of such men than from the rank and file. He was puzzled when he found so many working men who considered it commendable strategy to curtail or limit production, an example being the fitter, who told his manager that he "was out to get as much as he could for doing as little as he could."

Contracts Open.

Johannesburg, November 1.—Axles and bushes, for the Town Council. The Department of Overseas Trade. (Reference A.X. 6932.)

Angora, October 30.—Overhead electric travelling crane, for the Direction Generale des Chemins de fer et Ports d'Etat. The Department of Overseas Trade. (Reference A.X. 6954.)

Antwerp, November 8.—One twin-screw bucket dredger, for the Municipality. The Department of Overseas Trade. (Reference A.X. 6925.)

Athens.—One 35-ton floating crane and one 35-ton block-lifting crane. The Department of Overseas Trade. (Reference A.X. 6917.)

Cairo, November 10.—Semi-Diesel type internal-combustion engine as a power unit for stone-crushing plant, for the Egyptian Ministry of Public Works. The Department of Overseas Trade. (Reference A.X. 6967.)

London, S.W., October 19.—(1) Locomotive boilers (23); (2) bogie covered goods wagons (six); and (3) cast-iron chairs and distance blocks, for the South India Railway Company, 91, Petty France, Westminster, S.W.1. (Fees £1 for specification (1), 10s. for (2), and 5s. for (3), non-returnable.)

Melbourne, November 28.—One 10-ton overhead electric crane, for the Victorian Railways. The Department of Overseas Trade. (Reference A.X. 6951.)

Reports and Dividends.

Tinsley Rolling Mills Company, Limited.—Credit balance, including amount brought in, £9,017; preference dividends to June 30, £2,100; no dividend on ordinary shares; to reserve fund, £2,000; carried forward, £4,917.

Parsons Marine Steam Turbine Company, Limited.—Available profit, after writing off expenditure on development work and providing for depreciation, etc., £22,494; brought forward, £32,459; dividend at the rate of 10 per cent. per annum, tax free, £21,128; carried forward, £33,825.

Agricultural and General Engineers, Limited.—Trading profit of associated companies, £471,119; net profit, £148,379; net balance, after providing for depreciation, etc., £53,945; total revenue of parent company, £90,309, against £58,008; net balance, £35,840; carried forward, £103,185.

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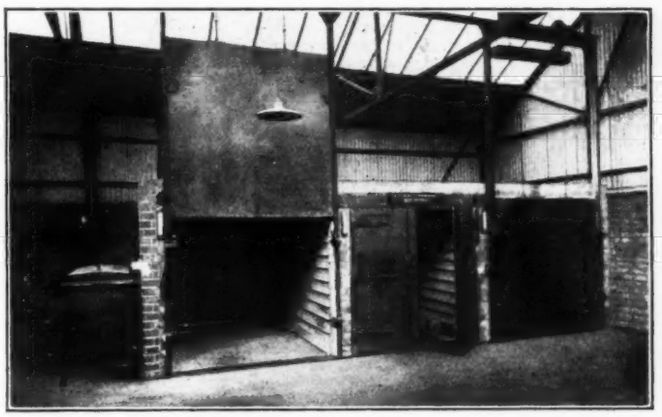

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Iron and Steel Markets.

Pig-Iron.

MIDDLESBROUGH.—Business in the Cleveland pig-iron market during the current week shows few indications of the long-expected improvement, and one instance, in fact, evidences a further movement in the opposite direction. This allusion refers to the reported failure of negotiations by Tees-side ironmasters with the Scottish Light Castings Association for the renewal of their contract which has just expired, the amount involved being stated at 15,000 tons, which is said to have been divided between the Stanton Ironworks and Midland furnaces. Terms have not been disclosed, but it is now definitely understood that the contract has been lost to Cleveland, with, unfortunately, little present hope of compensation from other sources, both home and export demands being still restricted by the comparatively high rates current. These remain unchanged as follow:—No. 1 Cleveland foundry iron, 68s. 6d. per ton; No. 3 G.M.B., 66s.; No. 4 foundry, 65s.; No. 4 forge, 64s. 6d. per ton.

The East Coast hematite market continues the improvement recently noted, accumulated stocks having been almost entirely sold and, while orders for prompt delivery can still be executed, there might be difficulty and delay in making up a substantial order. Thus makers are in a position to insist on 70s. per ton as a minimum price for mixed numbers and 70s. 6d. for No. 1 quality, and these figures are being freely paid. On the North-West Coast also prices are hardening, Bessemer mixed numbers being quoted firmly at 68s. 6d. per ton.

LANCASHIRE.—Only a moderate volume of business has been transacted in the local markets for foundry pig this week, and contracts placed forward have been on a limited scale. There has been practically no change in the price situation. For delivery equal to Manchester, Derbyshire makers are quoting 67s. 6d. per ton, Staffordshire 67s., Cleveland 79s., and Scottish from 87s. 6d. to 90s., according to brand.

THE MIDLANDS.—Local furnaces report that considerably more pig-iron has been contracted for during the last fortnight, and they appear sanguine that a definite improvement has set in and that still better values will obtain before very long. The higher prices which were quoted last week are maintained, and 60s. is now the minimum figure for Derbyshire No. 3. Northants. No. 3 varies somewhat at from 56s. to 57s. 6d. f.o.t., while North Staffordshire remains firm at between 60s. and 60s. 6d. f.o.t.

SCOTLAND.—No improvement can be reported in the inquiry for Scotch pig-iron, and the few furnaces in operation are quite able to take care of the demand. Founders generally complain of lack of orders, and for this reason they are not prepared to contract ahead. Prices are unchanged, and it is a matter of comment that makers should continue to produce pig-iron and sell it at a price which does not cover the cost of ore and fuel.

Finished Iron.

Throughout the Black Country area many manufacturers of this class of material report a slight improvement in business conditions as applying to marked bars and the better qualities of iron; the former being still quoted at £12 at makers' works, and the makers are a little more confident of the immediate future regarding material of this nature. There are no signs, however, that the position in relation to crown and the cheaper grades of iron is in any way affected, and the utmost difficulty is experienced in getting substantial orders for iron in this category. There exists considerable competition between the Lancashire, Derbyshire and Staffordshire works for what little business is circulating from the Midlands for crown iron, and quotations continue at £9 to £9 15s. per ton. The local price for nut and bolt iron is round £8 15s. to £9 per ton, although from outside districts it can be obtained at 1s. or so below the first-named price.

Steel.

So far as semi-finished material is concerned, business with the Continent has become intermittent in character, as most of the foreign works are quoting long periods for delivery, and prices which are scarcely competitive with those demanded by the British makers. As a consequence, the British producers of semi-finished steel are receiving a good share of the business passing. The finished steel department has been somewhat quiet, and there is a general tendency on the part of buyers, both at home and abroad, to restrict their orders to near requirements. It is believed, however, that stocks abroad are not large, and that considerable development in the export trade may be looked for later on. In the tinplate market prices are a shade higher all round. A considerable number of orders was fixed up on a basis of 18s. 1½d. to 18s. 4½d. for coke tins, net cash, f.o.b. Welsh ports.

Scrap.

Markets for foundry scrap metals, though by no means active as a rule, are still showing a moderate amount of business, with prices varying according to locality and the state of the demand. In the North-East area the foundries are taking fairly good lots of heavy cast iron at 60s. per ton for ordinary quality, whilst machinery quality in handy sizes realises up at 65s. At Birmingham there is an improved demand for cast-iron scrap, and prices are undoubtedly firmer than has been the case for some time past. For heavy cast-iron scrap in cupola sizes 65s. delivered is offered by the local foundries, and 52s. 6d. to 55s. delivered for light cast-iron scrap. In Scotland machinery cast-iron scrap is still in slow demand, and sellers offering this material at 66s. per ton find difficulty in getting a buyer. Ordinary heavy cast iron, suitable for foundries, is in better demand, and the current price is around 61s. 3d. Old cast-iron railway chairs are 65s. per ton, light cast-iron scrap 57s. 6d. to 58s. 6d., and cast-iron firebars 54s. to 55s. The above prices are all per ton, delivered f.o.t. consumers' works.

Metals.

Copper.—Few fluctuations in values of warrant copper have been recorded during the current week, and the trifling changes have on no occasion been of outstanding market importance. Advices from America state that the markets there have also been almost entirely featureless following the very heavy business that passed lately; there has been a lull in buying, but the position is quite firm. The well-sold situation, together with the generally favourable outlook in the copper industry as a whole, can only lead to the belief that an advance in prices may be expected in the near future.

Closing quotations are :—

Cash.—Thursday, £64 15s. to £64 17s. 6d.; Friday, £64 17s. 5d. to £64 18s. 9d.; Monday, £64 17s. 5d. to £64 18s. 9d.; Tuesday, £64 18s. 9d. to £65; Wednesday, £64 18s. 9d. to £65.

Three Months.—Thursday, £65 5s. to £65 6s. 3d.; Friday, £65 6s. 3d. to £65 7s. 5d.; Monday, £65 6s. 3d. to £65 7s. 6d.; Tuesday, £65 6s. 3d. to £65 7s. 6d.; Wednesday, £65 7s. 6d. to £65 8s. 9d.

Tin.—Following the publication of the tin statistics for September, the markets generally have taken an adverse view of the position, with erratic movements in values of almost daily occurrence. At the moment it is difficult to conjecture whether there will be a rise or fall in the near future, that naturally depending on the activities of the group who have been behind the hectic changes experienced of late. It is expected that further efforts will be made, either to raise the value or, at least, to hold it firmly at its present levels.

Official closing prices :—

Cash.—Thursday, £219 12s. 6d. to £219 15s.; Friday, £219 to £219 2s. 6d.; Monday, £220 to £220 2s. 6d.; Tuesday, £220 to £220 5s.; Wednesday, £220 17s. 6d. to £221.

Three Months.—Thursday, £217 to £217 5s.; Friday, £216 10s. to £216 15s.; Monday, £217 10s. to £217 15s.; Tuesday, £218 to £218 5s.; Wednesday, £218 7s. 6d. to £218 10s.

Spelter.—The position of ordinary spelter continues weak, buyers hesitating to come forward in support of the metal, the price of which still drags along round about £24. Demand from galvanisers is fairly good, but sufficient supplies are coming forward to meet all requirements, and there does not seem to be any expectation of startling developments in this market.

Daily quotations are :—

Ordinary.—Thursday, £23 18s. 9d.; Friday, £24; Monday, £24; Tuesday, £24; Wednesday, £24 2s. 6d.

Lead.—The trouble in the Australian shipping industry has had the effect of increasing the demand for lead from consumers. The shipments for both last month and this current month are bound to be light, and offers have tended to tighten and the tone of the market has stiffened a little.

Closing prices :—

Soft Foreign Prompt.—Thursday, £22 2s. 6d.; Friday, £22 3s. 9d.; Monday, £22 5s.; Tuesday, £22 5s.; Wednesday, £22 5s.

Institute of British Foundrymen.

NEWCASTLE BRANCH.

(*Continued from page* 288.)

accounted for the slow progress. It would be one of the greatest steps towards progress if they could educate the young men and break down the conservatism of the older men.

Chairman's Reply.

In replying to the discussion, Mr. Gresty said that, in his experience, he had not come across any special difficulties with iron containing 0.4 to 0.6 per cent. of phosphorus. At present, the existence of a critical phosphorus content as suggested by Mr. Cook was merely a theory, and, in his (Mr. Gresty's) opinion, definite proof was required before it could be accepted.

He was interested in Mr. Patterson's remarks about sand mixing and handling plant. Very little plant of that nature was seen in heavy foundries, where most of the mixing was done in ordinary pug mills requiring much hand labour. He thought the experiments on synthetic sand which Mr. Patterson was going to make would be of great interest to them all, and hoped that, later on, Mr. Patterson would be good enough to give a Paper to the Branch on the subject.

With reference to the question of tapping and pouring temperature mentioned by Mr. Thomas, Mr. Gresty said that without knowing the type of metal and casting which Mr. Thomas had in mind, he could not state actual figures. In general terms, however, special irons required higher temperatures than ordinary iron on account of their shorter freezing range, and, therefore, their greater liability to trap gases.

Replying to Mr. Paulin's remarks regarding analysis of scrap, Mr. Gresty pointed out that the chief thing was to get away from the idea of "selected scrap." If the scrap was taken indiscriminately from the scrap heap it would be found that its average analysis would be fairly constant, whereas, by selection, the tendency was to get only one grade of scrap which would thus practically control the whole mixture.

He agreed with Mr. Shaw's opinion that for heat-resisting castings low phosphorus was essential; also, that the chief reason for the value of cold-blast iron was its low carbon content.

Referring to Mr. Allan's remarks on the conservatism of foundry workers, Mr. Gresty said that some time ago he had seen a mechanical engineer's handbook dated 1834, *i.e.*, almost 100 years ago. Out of interest he had turned to the section on cupola practice and found that the description given was typical of the methods till used in a large number of foundries at the present time.

A vote of thanks to Mr. Gresty for his address was proposed by Mr. Paulin, seconded by Mr. Molyneux, and passed unanimously, Mr. Gresty replying briefly.

A Useful Folder.

The Bureau of Information on Nickel, Limited, 2, Metal Exchange Buildings, Leadenhall Avenue, London, E.C.3, have sent us a folder designed to carry in an ordered manner the bulletins which they issue from time to time. Apart from containing a complete series of previous publications, we were delighted to find a fresh one devoted to the use of nickel in non-ferrous castings. The scope of the brochure covers nickel brass, nickel silver, nickel manganese bronze, nickel aluminium bronze, nickel copper and "Y" alloy. Of particular use is the table on page 8, which details the typical compositions of the alloys under review, whilst the selected bibliography on page 9 has been well chosen, for its value to the specialised metallurgist is unquestionable.

Sterling

MOULDING BOXES

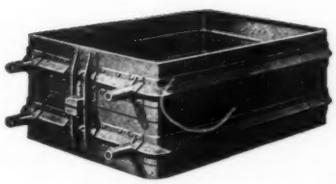
¶ LIGHTNESS AND EASE OF HANDLING;
¶ ROBUST CONSTRUCTION;
¶ DURABILITY AND LONG LIFE;
¶ PERMANENT ACCURACY.

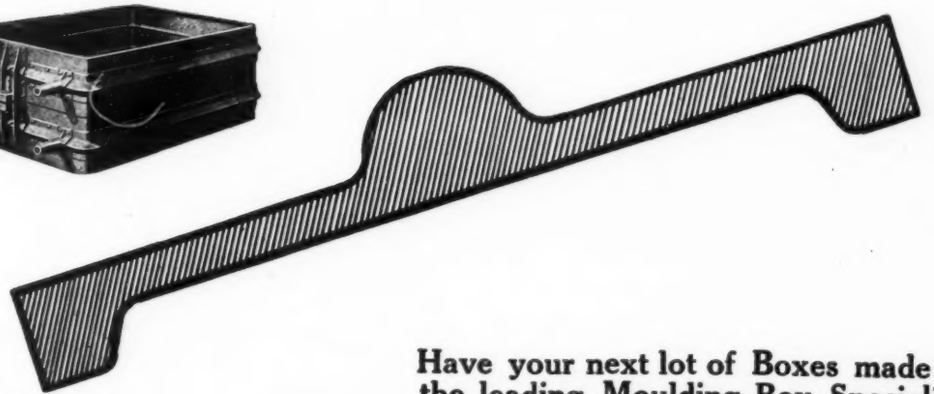
These are the paramount essentials of the modern moulding box.

Sterling Boxes embody all these qualities. They are made from solid ribbed rolled steel of the special section shown below.

Some of the largest and most up-to-date foundries in the country are now completely equipped with Sterling Boxes.

All Sterling Boxes are made to suit the individual requirements of each Foundry. We will drill them to match up to your existing pattern plates or odd-sides and fit them with bars to suit your special patterns.





Have your next lot of Boxes made by the leading Moulding Box Specialists.

STERLING FOUNDRY SPECIALTIES LTD.

London Office:
13, VICTORIA STREET, S.W.1.

BEDFORD

Telephone: 3345 BEDFORD
Telegrams: "STERFLASK, BEDFORD."
Code: WESTERN UNION.

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash ..	..64	18	6
Three months ..	..65	7	6
Electrolytic	..71	5	0
Tough	..68	0	0
Best selected ..	..68	0	0
Sheets	. 96	0	0
India	..78	0	0
Wire bars	..71	17	6
Do. October ..	..71	12	6
Do. November ..	..71	12	6
Ingot bars	..71	12	6
H.C. Wire rods ..	..75	15	0
Off. av. cash, September	..63	11	3
Do. 3 mths., September	..64	1	8¼
Do., Stilmnt., September	..63	11	3
Do., Electro, September	..70	1	0
Do., B.S., September	..66	19	4½
Aver. spot price, copper, Sep.	63	11	3
Do., Wire bars, September	70	6	0
Solid drawn tubes			13¼d.
Brazed tubes			13¾d.
Wire			10d.

BRASS.

Solid drawn tubes	12d.
Brazed tubes	14d.
Rods, drawn	11½d.
Rods, extd. or rlld. ..	7½d.
Sheets to 10 w.g.	10½d.
Wire	10½d.
Rolled metal	9½d.
Yellow metal rods	7½d.
Do. 4 × 4 Squares ..	8d.
Do. 4 × 3 Sheets ..	8¼d.

TIN.

Standard cash ..	220	17	6
Three months ..	218	7	6
English	220	5	0
Bars	224	0	0
Straits	221	5	0
Australian	221	15	0
Eastern	222	15	0
Banca	226	15	0
Off. av. cash, September	215	15	7½
Do., 3 mths., September	212	17	3
Do., Stilmt., September	215	15	3
Aver. spot, September ..	215	15	7½

SPELTER.

Ordinary	..24	2	6
Remelted	..22	15	0
Hard	..19	10	0
Electro 99.9	..27	10	0
English	..24	7	6
India	..20	10	0
Zinc dust .. (Nom.)	35	5	0
Zinc ashes	..7	15	0
Off. aver., September	..24	11	2¼
Aver., spot, September	..24	9	11½

LEAD.

Soft foreign ppt. ..	..22	5	0
English	..23	10	0
Off. average, September	..21	18	2¾
Average spot, September	..22	1	0

ZINC SHEETS, &c.

Zinc sheets, English	..33	0	0
Do. V.M. ex whf.	..31	5	0
Rods	..39	0	0
Boiler plates	..29	0	0
Battery plates ..	..30	10	0

ANTIMONY.

Special brands, Eng.	..59	0	0
Chinese	..40	10	0
Crude	..33	10	0

QUICKSILVER.

Quicksilver	..23	7	6

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—			
25%	7	17	6
45/50%	12	0	0
75%	19	0	0

Ferro-vanadium—	
35/50%	..14/- lb. Va.
Ferro-molybdenum—	
70/75% c. free ..	..4/3 lb. Mo.
Ferro-titanium—	
23/25% carbonless ..	1/1 lb.
Ferro-phosphorus, 20/25%	£18 0 0
Ferro-tungsten—	
80/85%, c. fr.	1/3 lb.
Tungsten metal powder—	
98/99%	1/8 lb.
Ferro-chrome—	
2/4% car.	£30 0 0
4/6% car.	£21 2 6
6/8% car.	£20 0 0
8/10% car.	£20 0 0
Ferro-chrome—	
Max. 2% car.	£32 10 0
Max. 1% car.	£37 0 0
Max. 0.70% car.	£42 0 0
70% carbonless	1/- lb.
Nickel—99% cubes or pellets	£175 0 0
Ferro-cobalt	9/- lb.
Aluminium 98/99%	£98 0 0
Metallic chromium—	
96/98%	2/7 lb.
Ferro-manganese (net)—	
76/80% loose	£13 15 0
76/80% packed	£14 15 0
76/80% export	£14 10 0
Metallic manganese—	
94/96% carbonless ..	1/6 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	£0	2	3
Finished bars, 18% tungsten	£0	2	9

Per lb. net, d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to ⅛ in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ½ in.	3d. lb.
Do., under ½ in. × ¼ in. ..	1/-lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

Scrap from high-speed tool steel—	
Scrap pieces	3d.
Turnings and swarf ..	1d.

Per lb. net, d/d steel makers' works.

SCRAP.

	£	s.	d.	£	s.	d.
South Wales—						
Hvy. steel	3	7	0 to	3	8	0
Bundled steel and shrngs. ..	3	1	0 to	3	2	6
Mixed iron and steel ..	3	0	0 to	3	2	6
Heavy cast iron	2	17	0 to	2	18	0
Good machinery for foundries				3	2	6
Cleveland—						
Heavy steel				2	15	0
Steel turnings				2	8	0
Cast iron borings ..				2	1	6
Heavy forge				3	10	0
Bushelled scrap ..				3	0	0
Cast-iron scrap				3	2	6
Lancashire—						
Cast-iron scrap	2	12	6 to	3	5	0
Hvy. wrought	3	2	6 to	3	5	0
Steel turnings	2	5	0 to	2	6	0

London—Merchants' buying prices delivered yard.

Copper (clean)	52	0	0
Brass	38	0	0
Lead (less usual draft) ..	18	10	0
Tea lead	15	10	0
Zinc	16	0	0
New aluminium cuttings ..	64	0	0
Braziery copper	49	0	0
Gunmetal	49	0	0
Hollow pewter	150	0	0
Shaped black pewter ..	105	0	0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	68/6
Foundry No. 3	66/-
Foundry No. 4	65/-
Forge No. 4	64/6
Hematite No. 1	70/9
Hematite M/Nos.	70/-
N.W. Coast—	
Hem. M/Nos. d/d Glas. ..	78/6
,, d/d Birm.	86/-
Midlands—	
Staffs. common*	67/6
,, No. 4 forge ..	56/-
,, No. 3 fdry... ..	60/-
Shrops. basic	—
,, Cold blast, ord.* ..	—
,, ,, roll iron* ..	—
* d/d Birmingham.	
Northants forge	53/6
,, fdry. No. 3 ..	56/-
Derbyshire forge	59/-
,, fdry. No. 3 ..	60/-
,, basic	65/-
Scotland—	
Foundry No. 1	75/-
,, No. 3	70/-
Hem. M/Nos.	74/-
Sheffield (d/d district)—	
Derby forge	61/-
,, fdry. No. 3 ..	65/-
Lincs. forge	62/6
,, fdry. No. 3 ..	65/-
E.C. hematite	81/-
W.C. hematite	84/-
Lincs. (at furnaces)—	
Forge No. 4	58/-
Foundry No. 3	60/6
Basic	60/6
Lancashire (d/d eq. Man.)—	
Derby forge	—
,, fdry. No. 3 ..	67/6
Northants foundry No. 3..	—
Dalzell, No. 3(special)	100/- to 102/6
Summerlee, No. 3	87/6 to 90/-
Glengarnock, No. 3	87/6 to 90/-
Gartsherrie, No. 3	87/6 to 90/-
Monkland, No. 3	87/6 to 90/-
Shotts, No. 3 ..	87/6 to 90/-

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.	£	s.	d.
Bars (cr.) nom.				10	5	0
Nut and bolt iron	8	12	6 to	8	17	6
Hoops				11	10	0
Marked bars (Staffs.) f.o.t.				12	0	0
Gas strip				11	10	0
Bolts and nuts, ½ in. × 4 in.				15	5	0
Steel—						
Ship plates..	8	7	6 to	8	12	6
Boiler plts...				10	10	0
Chequer plts.				10	12	6
Angles				7	17	6
Tees				8	17	6
Joists				7	17	6
Rounds and squares, 3 in. to 5½ in.				8	17	6
Rounds under 3 in. to ½ in. (Untested)				7	15	0
				and upwards		
Flats, over 5 in. wide and up				8	7	6
Flats, 5 in. to 1½ in. ..				7	17	6
Rails, heavy				8	10	0
Fishplates				12	10	0
Hoops (Staffs.)				10	0	0
Black sheets, 24g.	10	0	0 to	10	10	0
Galv. cor. shts. 24g.	13	10	0 to	13	15	0
Galv. fencing wire 8g. plain				12	10	0
Billets, soft	6	2	6 to	6	10	0
Billets, hard	7	2	6 to	7	12	6
Sheet bars				6	0	0
Tin bars				6	0	0

PHOSPHOR BRONZE.

	Per lb. base
Strip	1 2½
Sheet to 10 w.g.	1 3
Wire	1 4
Rods	1 3
Tubes	1 7½
Castings	1 2

Delivery 3 cwt. free.
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	per lb.
Ingots for raising ..	9d. to 1/3
Rolled—	
To 9 in. wide ..	1/3 to 1/9
To 12 in. wide ..	1/3½ to 1/9½
To 15 in. wide ..	1/3½ to 1/9½
To 18 in. wide ..	1/4 to 1/10
To 21 in. wide ..	1/4½ to 1/10½
To 25 in. wide ..	1/5 to 1/11
Ingots for spoons and forks	9d. to 1/5½
Ingots rolled to spoon size	1/- to 1/8½
Wire round—	
3/0 to 10 G.	1/6½ to 2/1½

with extras according to gauge.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols
No. 2X foundry, Phila. ..	20.75
No. 2 foundry, Valley ..	17.00
No. 2 foundry, Birm.	16.26
Basic	18.7
Bessemer	19.0
Malleable	19.00
Grey forge	18.20
Ferro-mang. 80% d/d	105.00
O.-h. rails, h'y at mill	43.00
Bess billets	32.00
O.-h. billets	32.00
O.-h. sheet bars	32.00
Wire rods	42.0
	Cents.
Iron bars, Phila.	2.12
Steel bars	1.90
Tank plates	1.90
Beams, etc.	1.90
Skelp, grooved steel	1.90
Skelp, sheared steel	1.90
Steel hoops	2.20
Sheets, black, No. 24	2.75
Sheets, galv., No. 24	3.50
Sheets, blue an'l'd., 9 and 10 ..	2.00
Wire nails	2.55
Plain wire	2.40
Barbed wire, galv.	3.20
Tinplates, 100 lb. box	$5.25

COKE (at ovens).

Welsh foundry	27/- to 35/-
,, furnace	19/- to 21/-
Durham and North.	
,, foundry	15/- to 15/6
,, furnace	14/-
Midlands, foundry	—
,, ,, furnace ..	13/6 to 14/6

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. Cokes ..	20×14 box	18/- to	18/3
,, ..	28×20 ,, ..		36/3
,, ..	20×10 ,, ..		26/6
,, ..	18½×14 ,, ..		19/-
C.W.	20×14 ,, ..		15/-
,, ...	28×20 ,, ..		33/6
,, ...	20×10 ,, ..		22/-
,, ...	18½×14 ,, ..		15/9
Terneplates ..	28×20		33/6 per box basis f.o.b.

SWEDISH IRON.

Bars, hammered,	£17 10 0 to £18 10 0
Rolled Ord. ..	£15 0 0 to £15 10 0
Nail rods ..	£15 7 6 to £15 15 0
Keg. steel nom. ..	..£32 to £33
Faggot steel nom. ..	£22 to £25
Blooms, according to quality	£8 to £12
Pig-iron ..	£5 15 0 to £6 0 0

all f.o.b. Gothenburg

TUBES AND FITTINGS.
Up to and incl. 6 in.

	Tubes.	*Fittings.*
Gas	67½%	50%
Water	63½%	45%
Steam	60%	40%

W.I. 10% extra.

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£	s.	d.		
Oct. 11		64	15	0	inc.	1/3
,, 12		64	17	6	,,	2/6
,, 15		64	17	6	No change	
,, 16		64	18	9	inc.	1/3
,, 17		64	18	9	No change	

Electrolytic Copper.

		£	s.	d.		
Oct. 11		71	5	0	No change	
,, 12		71	5	0	,,	,,
,, 15		71	5	0	,,	,,
,, 16		71	5	0	,,	,,
,, 17		71	5	0	,,	,,

Standard Tin (cash).

		£	s.	d.		
Oct. 11		219	12	6	dec.	22/6
,, 12		219	0	0	,,	12/6
,, 15		220	0	0	inc.	20/-
,, 16		220	0	0	No change	
,, 17		220	17	6	inc.	17/6

Tin (English ingots).

		£	s.	d.		
Oct. 11		218	10	0	dec.	15/-
,, 12		218	0	0	,,	10/-
,, 15		218	10	0	inc.	10/-
,, 16		219	5	0	,,	15/-
,, 17		220	5	0	inc.	20/-

Zinc Sheets (English).

		£	s.	d.		
Oct. 11		33	0	0	No change	
,, 12		33	0	0	,,	,,
,, 15		33	0	0	,,	,,
,, 16		33	0	0	,,	,,
,, 17		33	0	0	,,	,,

Spelter (ordinary).

		£	s.	d.		
Oct. 11		23	18	9	dec.	3/9
,, 12		24	0	0	inc.	1/3
,, 15		24	0	0	No change	
,, 16		24	0	0	,,	,,
,, 17		24	2	6	inc.	2/6

Lead (English).

		£	s.	d.		
Oct. 11		23	10	0	No change	
,, 12		23	10	0	,,	,,
,, 15		23	10	0	,,	,,
,, 16		23	10	0	,,	,,
,, 17		23	10	0	,,	,,

Exports of Iron Castings in September and the nine months 1928, compared with September and the nine months 1927.

	September, 1927.	September, 1928.	Nine months, 1927.	Nine months, 1928.	September, 1927.	September, 1928.	Nine months, 1927.	Nine months, 1928.
BUILDERS' CASTINGS—								
Stoves, Grates, etc., Cisterns, Baths, etc., and cooking and washing boilers:—	Tons.	Tons.	Tons.	Tons.	£	£	£	£
To Argentine Republic	152	104	1,211	1,327	6,354	3,753	45,763	55,123
,, British South Africa	236	202	2,052	2,641	9,422	7,590	75,019	92,657
,, ,, East Indies	64	71	817	1,099	4,168	3,100	37,056	47,954
,, Australia	61	30	714	489	3,770	1,976	41,002	33,827
,, New Zealand	178	91	1,556	1,377	8,553	5,763	78,519	70,690
,, Other countries	926	638	6,130	6,985	43,194	31,519	307,341	325,338
Total	1,617	1,136	12,480	13,918	75,461	53,719	584,700	625,589
PIPES AND FITTINGS—CAST—								
To Argentine Republic	415	575	6,944	6,909	4,826	6,879	76,732	71,194
,, British South Africa	1,025	374	8,593	3,514	10,888	4,564	101,998	54,397
,, ,, India	347	342	5,061	6,372	4,487	4,810	78,859	84,772
,, Straits Settlements and Malay States	1,611	793	11,586	11,428	14,511	8,688	113,071	105,049
,, Ceylon	96	34	1,125	1,631	967	422	13,129	16,621
,, Australia	727	876	6,871	7,337	8,739	7,910	81,304	80,070
,, Other countries	5,717	3,699	46,127	42,683	71,655	44,636	603,205	557,093
Total	9,938	6,693	86,307	79,874	116,073	77,909	1,068,298	970,196
HOLLOW-WARE—								
Cast, not Enamelled, and Cast, Tinned	446	255	3,480	3,343	18,381	12,710	137,488	126,557
,, Enamelled	60	45	525	566	6,917	5,213	53,931	54,432
CASTINGS, in the rough—								
Iron	121	174	909	1,206	4,033	4,532	32,742	37,357
Steel	137	43	729	455	6,099	1,630	33,787	21,064

WILLIAM JACKS & COMPANY,
WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

18, BENNETTS HILL, BIRMINGHAM.

PIG

IRON

SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM JACKS & COMPANY,
19, ST. VINCENT PLACE, GLASGOW.
ZETLAND ROAD, MIDDLESBROUGH.

SMALL ADVERTISEMENTS.

SITUATIONS VACANT AND WANTED.

REPRESENTATIVE, age 32, seeks position; first-class connection Midlands and South Wales; foundry and pneumatic plant and accessories.—Box 848, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

FOUNDRY FOREMAN desires post; finest experience; many classes of engineering work, machine moulding, organisation, management, etc.—Box 846, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

PNEULEC, LIMITED, require a Representative, with practical Foundry experience, for the Lancashire and Yorkshire district. Applicants should give full information with regard to experience, salary, etc.—Pneulec, Limited, Mafeking Road, Smethwick.

WORKS MANAGER, with modern Foundry, Pattern-shop and General Engineering experience, desires position and interest with small, progressive firm.—Box 842, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

MACHINERY.

SAND MIXERS.—New and second-hand. Ask us to quote.—W. Brealey & Company, Limited, Prospect Works, Hawksley Avenue, Sheffield.

'Phone **98** Staines.

Electric-driven High Pressure Blower, 6-in. delivery, 110 volts D.C.
Steam-driven Westinghouse Compressor, 150 c.f., 100 lbs. pressure.
Vertical Air Receiver, 8 ft. x 4 ft., 100 lbs. w.p.
100-h.p. Petter Twin Cylinder Vertical Crude Oil Engine.

Harry H. Gardam & Company, Limited, Staines.

No. 3 12-in. x 48-in. CINCINNATI Universal Cylindrical Grinding Machine.
Nearly new 12-in. x 42-in. LANDIS Plain Cylindrical Grinding Machine.
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LOMAX, SONS & MILLS have received instructions from the Liquidator herein to SELL BY AUCTION on the premises, as above, on THURSDAY, OCTOBER 25, 1928, commencing at eleven o'clock prompt, the Old-established

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The PROPERTY and CONTENTS in the FIRST INSTANCE will be offered as a WHOLE, and if not so disposed of the LAND and BUILDINGS will be offered together, and the PLANT disposed of PIECEMEAL, as per catalogue, which is now in the course of preparation.

For Catalogues apply to the Auctioneers, Clarence Buildings, 2, Booth Street, Manchester (Tel. 3668 Central), and Central Chambers, Bolton (Tel. 181); R. Smethurst, Esq.; Messrs. Grierson, Sons & Smethurst, Chartered Accountants, 21, Spring Gardens, Manchester; or to Messrs. Brownsword & Arnold, Solicitors, 86, King Street, Manchester.

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